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Engineering News-Record

Twenty-five cents, five dollars per year McGraw-Hill Publishing Company, Inc.

January 25, 1934

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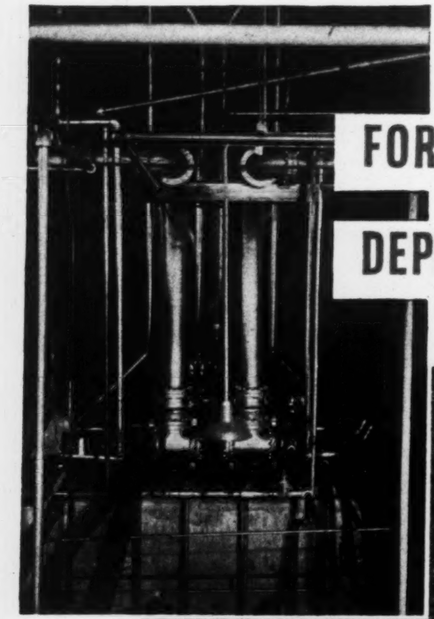

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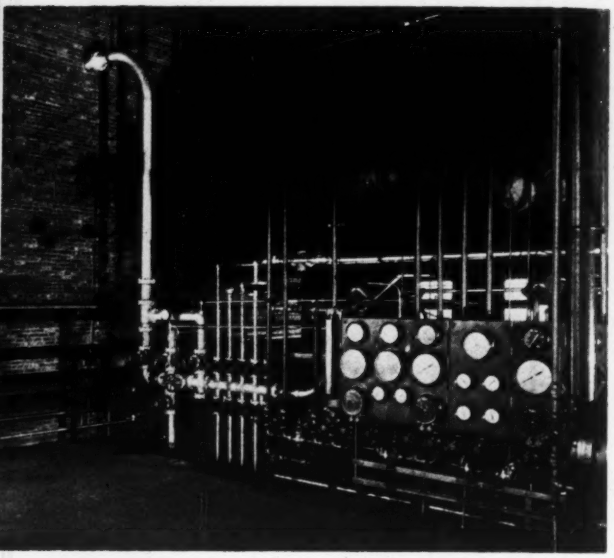

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ENGINEERING NEWS-RECORD

New York

January 25, 1934

CONCRETE PUMP LINES create a new kind of construction scene. View shows formwork for lower lift of intermediate lock wall inside cofferdam of lock 5.

Lock Concrete Placed by Pumping

Two new locks in the slackwater navigation plan for the upper Mississippi River, being pushed with Recovery Act funds, demonstrate capacity and speed of pumps for placing mass concrete

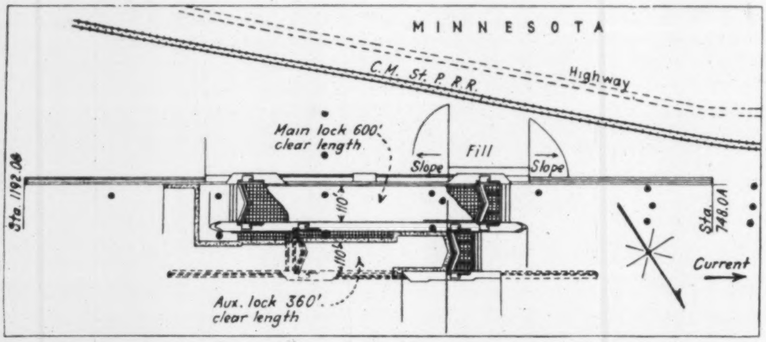
About 110,000 cu.yd. of concrete have been placed by pumping in building locks 4 and 5 of the upper Mississippi River slackwater navigation improvement. These locks are parts of the four lock-and-dam structures of the primary group of the four groups comprising 27 locks and dams composing the planned development. Lock and dam 15, of this primary group, located at Rock Island, Ill., will be completed in the spring of 1934, and dam 20 at Canton, Mo., is under contract as are dams 4 and 5.

Lock 4, now completed, is located about 90 miles below St. Paul, Minn., and about 10 miles below Lake Pepin, which gives it the largest pool of any of the 26 structures planned; and lock 5 is about 15 miles farther downstream and about the same distance above Winona, Minn. The town of Alma, Wis., is at lock 4, and lock 5 is on the Minnesota shore near the town of Minneiska. The locks are virtually identical structures, and only a plan and sections of lock 5 are shown here.

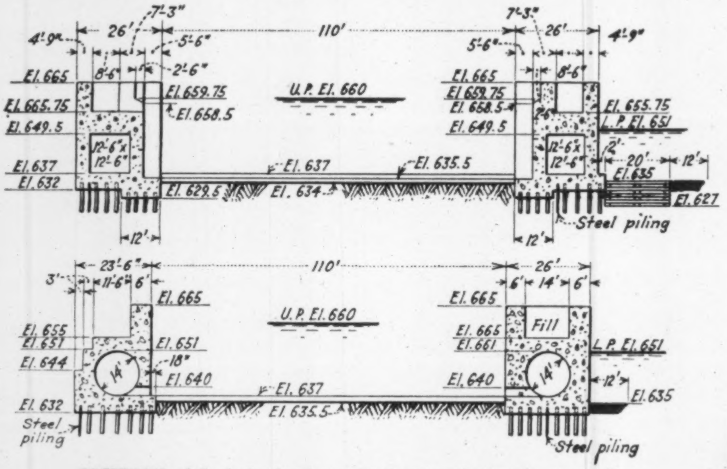
The type of structure and general dimensions are clear from the drawings. The present construction operations include the complete main lock and the upstream parts of the auxiliary lock, including the upper river bay, upper gate sill and miter gates and the emergency bulkhead foundation. Both locks (4 and 5) were carried on pile foundations and constructed within earthfilled cofferdams, made tight by lines of steel sheetpiling. Steel sheetpiling also forms a cutoff diaphragm under the lock walls. None of these structures offered construction difficulties out of those ordinary to river work. The unusual feature of the work was that the concrete was placed by pumping under a lease-contract with the Chain Belt Co., Milwaukee, Wis., using their concrete pump. The pumping operations at lock 4 are considered primarily, and those at lock 5 only as they represented important differences.

As shown by the illustrations, the lock was built within a cofferdam consisting of two arms extended outshore, their outer ends being connected by a long wall parallel to the bank. Alongshore and close to the bank are the tracks of the Chicago, Burlington & Quincy R.R., along which stretches the village of Alma. Both water and rail delivery of construction materials and equipment were possible and both were employed. The contractor began getting his plant installed in December, 1932, and in a few months the cofferdam had been completed and pumped out and the piledriving completed ready for concreting operations.

About 55,000 cu.yd. of concrete were required in the lock, auxiliary lock, guide walls and lock appurtenances. The specifications called for a concrete having a minimum compressive strength of 2,400 lb. and an average compressive strength of 3,200 lb., both in 28 days.



LOCATION PLAN of Lock 5, showing main lock and advance construction of upstream gate bays of auxiliary lock on upper Mississippi River navigation improvement.



SECTIONS of Lock 5, showing general types of concrete construction.

The proportioning was to be by the water-cement-ratio method using no less than 5 bags of cement per cubic yard and no more than 6½ gal. of water per bag of cement, including contained water in the aggregate. All proportioning was by weight, and, in general, using a maximum coarse aggregate of 3 in., the materials per cubic yard were about: 5 bags, or 470 lb. of cement; 1,350 lb. of fine aggregate dry; 2,150 lb. of coarse aggregate dry, and 32½ gal. of water. This mix produced a concrete weighing about 4,100 lb. per cubic yard having a strength of 2,410 lb. in 7 days and of 3,890 lb. in 28 days.

Plant layout

The specifications called for a very high type of weight-batching equipment. To receive sand and gravel by barge from Wabasha, 8 miles upstream, the mixing plant was located just inside the cofferdam at about midlength of the long river wall. It was arranged in four stories, in a steel frame, containing, from the top down, the storage bins, batching floor, mixer floor and concrete pump floor. A 1¼-yd. clamshell unloaded the barges into stockpiles or directly into the bins. The cement delivered by rail in bulk in steel cars was pumped across the cofferdam through 338 ft. of 4-in. flanged pipe suspended from a cable to the cement bin. The pump had a capacity of 120 bbl. an hour, and with due care an operator and two men in the car to feed the pump could keep the plant supplied with cement.

The steel bins held materials for 300 cu.yd. of concrete. All materials were weighed separately for batching, one dial scale being used, however, for sand and gravel, which were batched by hand. The cement was batched automatically using a separate scale with an electric cutoff. A double-beam scale weighed the water, one beam being used only to adjust for contained moisture; the water scale also had an electric cutoff. The mixing water was pumped from well points placed in the river. Two independent electrically driven 28-S (1-cu.yd.) mixers, set side by side under the batching floor and over the pump floor, were arranged to discharge by chute into either of the two pumps also set side by side. The mixers had a combined capacity of 60 cu.yd. an hour, with a mixing period of 1½ minutes.

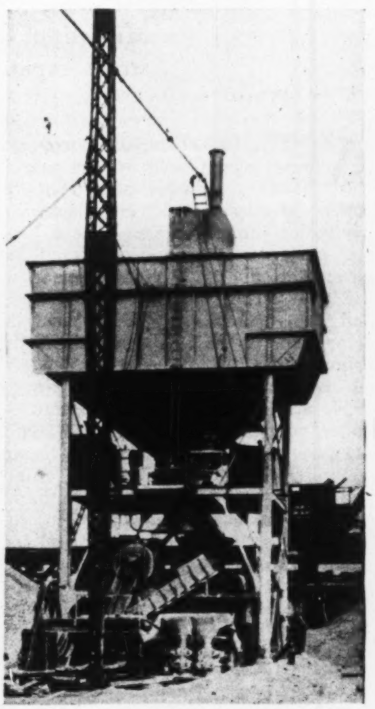
Pumps unusual feature

From the mixers the concrete was handled by pumps and pipe lines to the forms. The pumps were double-cylinder reciprocating machines much resembling in their operation the familiar duplex pump for water. Each was operated by a 55-hp. gasoline engine. A hopper over each cylinder received the concrete from the mixer. An agitating device in each hopper kept the concrete mixed, and the bottom of each hopper was opened and closed by a rotary valve feeding into the pump cylinder. With the cylinder filled, the feed valve closed and the discharge valve opened, the plunger moved forward, clearing the cylinder into the discharge pipe line. As in a water pump, the two cylinder units pumped alternately, keeping the discharge stream of concrete continuous.

In the pumps used, the plungers had a 12-in. stroke and a 7½-in. bore and were faced with rubber. The pump made about 45 strokes a minute. The rotary valves were operated by cam and roller action from the plunger crankshaft. To prevent valve breakage each valve stem contained a heavy spring which acted as a shock absorber in case a stone or other obstacle prevented complete closure. The valve openings were adjustable to the size of aggregate being used.

Ordinarily only one of the two pumps was needed to pump concrete, the other being held in reserve and used for pipe flushing as described later. A discharge Y was used, one arm coupling to each cylinder and the stem coupling to the discharge pipe line. The discharge pipe was made up in 10-ft. length, with flange and lever couplings

MIXING PLANT at lock 4, showing four-story construction with concrete pumps on lowest level, about same elevation as lock floor.

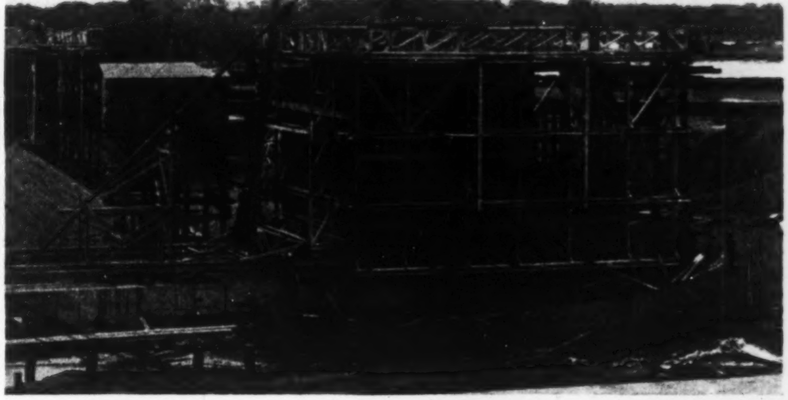


that could be quickly operated. A rubber gasket made each coupling tight. The pipe had a diameter of 7 in. outside and a $\frac{5}{32}$-in. shell; it was tested for 700 lb. per square inch.

Concreting procedure simple

The concreting procedure was as follows. As shown by the illustrations, the lock walls were concreted in sections, each section being carried up in horizontal lifts. The surface of each lift was cleaned and flushed with ½ in. of cement-sand grout before new concrete was placed. To start a new pour then, the pump was flushed with water and a free piston or go-devil was inserted in the pipe line. This piston, a rubber device, cleaned the pipe line and permitted the batch of grout for flushing the surface of the previous lift to be pumped behind it. The pump valves were then changed and concrete mixing and pumping began.

Movable forms with steel frame and wood panels were used, and about 2,200 ft. of pipe line was employed to serve the forms. This amount was provided to reduce delays in concrete placing because of frequent shifting of pipe line as the location of the parts being concreted changed. With about double the pipe required in the longest run of pipe line, a line could be laid to the new point of placement and the pump connected to it as soon as the previous pour had been run. The pipe that had just been in use could then be picked up and relaid to the next part of the lock to be concreted.

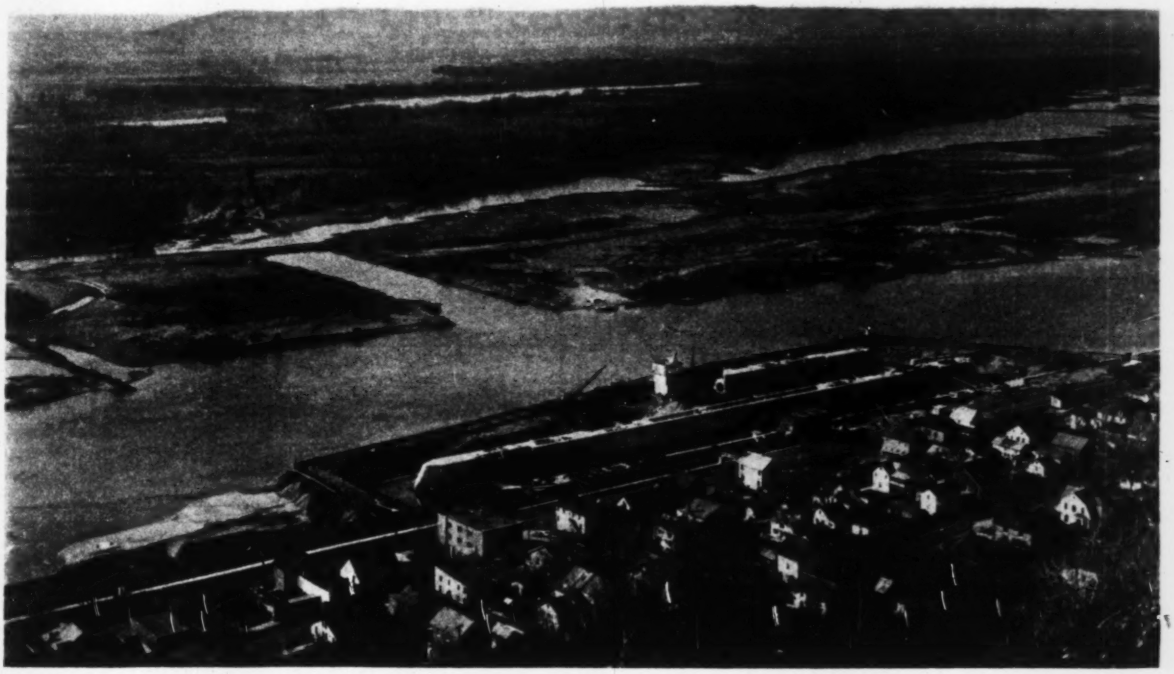


FOOTING LIFT of lock walls and forms for sections of upper walls, showing gooseneck discharge end of pump line supported clear of forms.

Pipe-line alignment was kept as direct as possible for the obvious reason that in pumping concrete, as in pumpany any liquid or semi-liquid, friction head is increased by pipe bends. But bends were introduced as freely as was necessary and, with some care to change direction gently, the movement of the concrete was free and steady. In profile the line was kept about level but without wasting effort for precision. At the forms the delivery end of the line was bent up at an angle of about 45 deg. to extend 6 or 8 ft. above the top of the form, and there bent into a gooseneck to deliver to vertical spouts extending down into the form. To keep the surge of the pumping from jarring the forms, the gooseneck discharge end was supported by an A-frame.

The procedure at the start of pumping has been indicated. In regular operation close signals were maintained between the crew at the forms and those at the mixers and pumps so that pumping could be promptly stopped when changing chutes, spading or other operations at the forms required delivery of concrete to be delayed. A

COFFERDAM and concrete work for lock 4 toward end of operations, showing beginning of excavations for dam. Village of Alma, Wis., is in foreground.



EARLY CONCRETING on lock 4, showing mixing plant and suspended pipe line through which it receives cement by pumping from railway cars on shore.

crew of eight men using spades and vibrators puddled the concrete in the forms. At the completion of a run of concreting the final operation was to clear the pipe line of concrete.

As the end of the run aproached, watch was kept of the volume needed to finish the run, and when this equalled the known yardage in the pipe line pumping was stopped and the line was blocked. The go-devil, or free piston, was then inserted in the pipe line at the pump end, the line was reconnected and unblocked and water was pumped into the line behind the piston and the remaining concrete was forced out, taking care to divert the last remnant of discharge outside the forms just before the free piston and the water reached the discharge end. From ¼ to ½ cu.yd. of concrete was wasted in this operation.

Performance records good

Conclusions on performance are somewhat fragmentary. In a measure the work was a large-volume try-out both of the pumping equipment and of works organization. About 55,000 cu. yd. were pumped. Pump performance was limited generally by progress at the forms. All the concrete was placed in about 5 months from May 15 to Oct. 18, 1933. With one pump working, the maximum week's work was 5,000 cu.yd. The maximum distances pumped were 1,150 ft. horizontal, 50 ft. vertical, and 1,000 ft. horizontal and 50 ft. vertical combined. These data are from the subcontractor for the pumping.

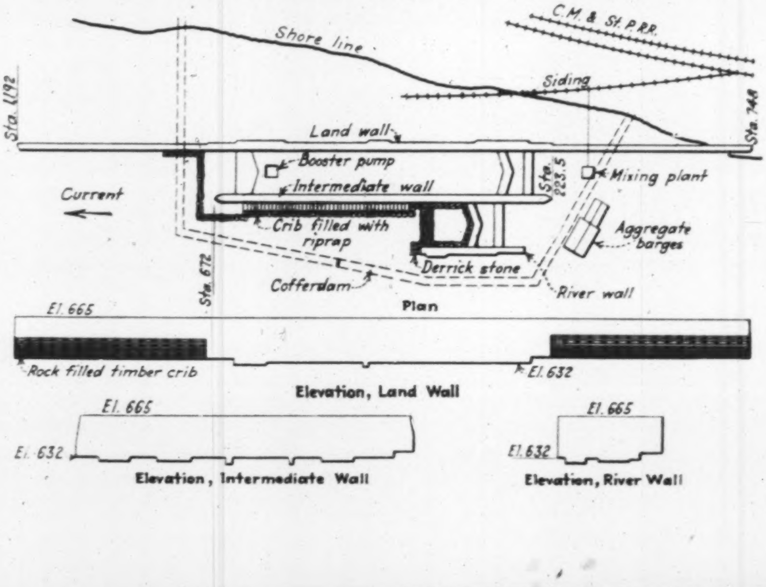
From a statement prepared by F. E. Cothran, First Lieutenant, Corps of Engineers, stationed as observer on the pumping operations, the following conclusions appear:

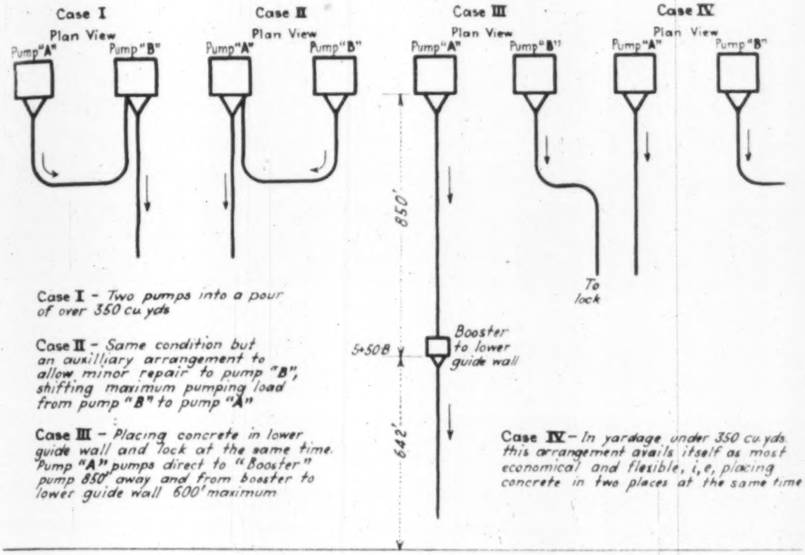
> Efficiency in concrete pumping as in other methods of concrete placement depends upon layout and planning of operations, such as the construction and preparation of forms, the timing of material supply and the coordination of the work. About ten shutdowns might be charged against this method. Some of the causes of delay in pumping were chunks of old concrete falling into the machine; changing pulley ratio; failure of clamps and gaskets on pipe lines; worn valves causing lack of power; leaking gaskets due to poor layout of pipe line; worn or deficient rubber washers on the go-devil; and attempts to pump under conditions overtaxing the power of the pump. The local operator stated that the majority of the shutdowns were due to test and development, and a far better performance was indicated for the future.
>
> The pipe line demands careful placement and alignment, with due regard for its function. A foreman and four laborers were kept at work caring for the pipe line. The pumps actually placed concrete through 1,200 ft. of pipe, with a vertical lift of 35 ft. requiring 15 min. from pump to form, pumping about 45 yd. per hour, including form delays. In another attempt with a more difficult layout of pipe line and with worn valves, failure occurred. The form delays noted prevented the pump from reaching its maximum yardage per hour, but were necessary for good spading. About 483 yd. per day of 24 hours was the average placement attained for the season, with the form construction rather than the pumps restricting increased production. From 800 to 1,000 ft. of pipe with a 40-ft. lift was about the limit of operations of the arrangement used without possibility of delay.
>
> Good concrete, well mixed, with a good proportion of cement and fines in the sand seems to be essential. A dry batch cannot be pumped, and a wet concrete will also cause clogging. The hoppers must be watched closely for consistency and for anything that may cause clogging.

In the lease contract, which was on the basis of a rental rate per cubic yard, the operation of the pumps was under the direction of the lessor's operators. From their experience the following statements are informative:

> At least 90 per cent of the concrete pumped was placed within an area that did not involve excessive pumping distances. From 5 per cent to 10 per cent was placed with pipe-line lengths and lifts considerably greater than the guaranteed pumping limits of the pump. Approximately 75 per cent of the delays due to the system occurred during attempts to pump excessive distances. The pulley ratio change was made only to take care of these excessive distances and was in the nature of an experiment.
>
> It can be stated very definitely that there was not one single breakdown of the pump as a machine or of the system as a system. There were shutdowns or delays due to line plugs. The contractor's records show that only a total of 72 hours up to Sept. 30, 1933, were used in making mechanical repairs other than minor adjustments, greasing, etc., and all of the repairs were made at times that did not

LOCK COFFERDAM and plant layout plan at lock 5.




Case I
Plan View
Pump "A"
Pump "B"
Case II
Plan View
Pump "A"
Pump "B"
Case III
Plan View
Pump "A"
Pump "B"
Case IV
Plan View
Pump "A"
Pump "B"
850'
642'
5+50B
Booster to lower guide wall
To lock
Case I - Two pumps into a pour of over 350 cu yds
Case II - Same condition but an auxilliary arrangement to allow minor repair to pump "B", shifting maximum pumping load from pump "B" to pump "A"
Case III - Placing concrete in lower guide wall and lock at the same time. Pump "A" pumps direct to "Booster" pump 850' away and from booster to lower guide wall 600' maximum
Case IV - In yardage under 350 cu yds this arrangement avails itself as most economical and flexible, i, e, placing concrete in two places at the same time

DIAGRAMS of four pumping arrangements employed in concreting lock 5.

interfere with the operation of the job or cause actual delay to the contractor. To summarize: (1) There were no mechanical break-downs on the job; (2) the cost of replacement parts for this job averaged $0.028 per cubic yard; and (3) of the time lost due to delays and shutdowns caused by line plugs, 75 per cent could have been avoided if the contractor had not endeavored to pump beyond the guaranteed pumping distance, and the reason the contractor on his own initiative attempted to go beyond the guaranteed pumping distance was that he could and did save money.

The contractor for lock 4 was the Ouilmette Construction & Engineering Co., Chicago, Ill., with P. C. Peterson as general superintendent. W. D. Fairchild was resident engineer for the government.

Procedure changed at lock 5

Practically the same structures and the same cofferdam arrangements as at lock 4 were employed at lock 5. Two duplex concrete pumps were employed, and pumps, pipe-line and pumping appurtenances were the same. The same carefully equipped batching and mixing plant was required, and all controlling specifications were the same. Only differences in practice are therefore considered.

Referring to the layout plan, the mixing plant was located about on the axial line of the lock inside the upstream end wall of the cofferdam. The aggregates were delivered by barges and the cement by railway. A cable-haul incline trestle was constructed from the cement-car siding to the top of the mixing-plant bins, and the bulk cement was loaded into skip cars which dumped into the cement bin. Forms and general placement methods were about like those on lock 4.

A notable variation in pumping practice was introduced by combining pumping power for long runs, using booster pumps and other arrangements as shown by the accompanying diagrams. These arrangements did much to make the pumping method more flexible. The contractor for lock 5 was the E. F. Gillen Co., Milwaukee, Wis., with E. E. Beauvais in field charge.

Direction of work

Construction of locks 4 and 5 is a part of the development of 9-ft. navigation on the upper Mississippi River by the Corps of Engineers, U.S.A. Col. E. L. Daly, St. Louis, Mo., who recently succeeded Col. George E. Spalding, is division engineer, and Maj. Dwight F. Johns, St. Paul, Minn., is district engineer.

Erosion Control in Kentucky by C.C.C. Forces

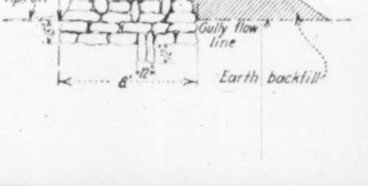
Brush, stone and log barriers built as check dams to prevent further wash of gullies—Intercepting ditches concentrate floodflow—Extensive program to save farmlands

By Russell Woodburn
Civil Engineer, Kentucky State Forest Service

FORCES of the Civilian Conservation Corps are at work on a large number of small erosion-control projects in western Kentucky. In this district are extensive areas once farmed but now lost to cultivation through erosion. Except for creek and river bottomlands, the topography is quite hilly. Originally these hills were covered with a heavy forest growth that was cleared away to make farming possible.

Without the protection of the forest cover, these lands have eroded badly in the form of gullies. The slopes of the hills range from 5 to 50 per cent, and in all cases observed the size of the gully has no constant relation to the slope of hill. The most extensive gullying seems to be in the range of slope from 15 to 20 per cent. The larger gullies are near the hill tops, and drainage areas of 1 to 3 acres have produced almost unbelievable scour. Utilization of the C.C.C. forces in this district to prevent further erosion and subsequent destroying of farmland, and also as an aid to flood control, was deemed worth while.

FIG. 1—CROSS-SECTION of typical stone dam being built as check barriers.


3'-6"
3'
18"
Slope 1½ to 1
6' to weir
Silt retaining basin
Apron
Gully flow line
12"
12"
8'
Earth backfill

In very few cases is it practicable or desirable to attempt to restore the treated areas to cultivation. All structural treatment and subsequent planting with grass or seedlings is only for the purpose of checking erosion and preventing the transportation of silt to fertile lowlands and to streams. Agreements for work are made only with land owners having very badly gullied tracts that are so far gone as to preclude the possibility of a private owner having means to handle the situation.

There is no standard treatment of the gullies, but in general it has been found advisable to connect as many adjacent gullies as possible with intercepting ditches, to concentrate the flow into one, and in this one to construct substantial check dams. In selecting the gully for detail treatment, care is

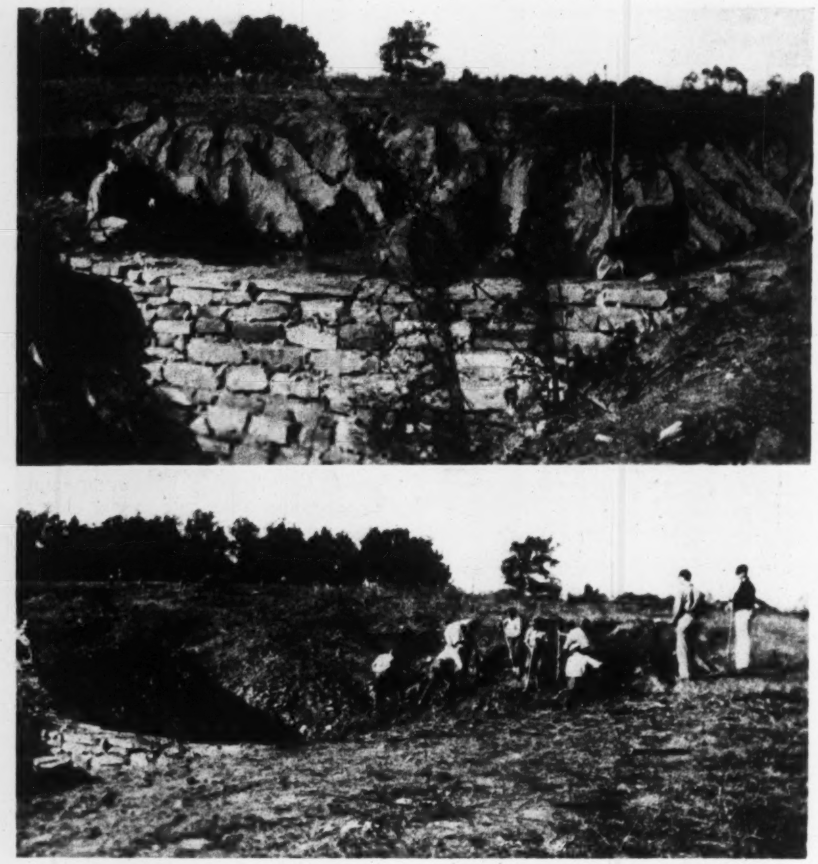


FIG. 2—CHECKING GULLY EROSION in western Kentucky with CCC forces. Above is a typical stone check dam built by hand, with the character of gully erosion being treated shown in the background. Below is a view of the same project showing grading of sides of gully to permit planting of grasses and seedlings.

taken to select the one through which the original natural course of the water moved from the hillside. It is important that the gully selected have side slopes able to hold the dams constructed and that it is not so wide as to require very long span structures. When the flow from the remaining gullies has been diverted into a main gully by intercepting ditches and diversion fills, the problem of checking erosion is greatly simplified. Then in the remaining gullies the side slopes may be graded down to a planting grade, usually 1½:1 or flatter. In addition to the flow diversion at the head of each gully, it is also general practice to construct across these gullies check dams of some sort to retain loose material which may work downstream.

An attempt is made in all cases to treat an area with materials found near by, and stone, logs, poles or brush are all used for construction of the check dams. The limited amount of material available complicates the problem.

New arrangement of check dams

The theories and practice of erosion control are not new in this country. Considerable study and research have been made by the U.S. Department of Agriculture and by many states. The methods used here are not new, but in many cases have been altered somewhat to meet conditions. For example, check dams have ordinarily been so placed in a gully that the top of one dam is below the base of the next dam upstream by a deposition gradient of 0.5 per cent. If this specification is rigidly followed on steep slopes, and if dams are constructed to maximum height permissible for the sort of material used, the dams are apt to be very close together and an excessive number is required. In the writer's opinion, when the material is scarce the method previously outlined (that is, intercepting the flow at the head of the gully and sloping the banks for planting, and constructing a substantial check dam across the gully throat) is preferable to the deposition gradient scheme. When banks have been properly sloped, resulting in loose material of 1 ft. or more in depth on the slopes, it has been observed that a substantial portion of the rainfall is retained in this loose material.

In the general problem of slipping in gully banks and leveling an area for planting, it has been found that the use of explosives in breaking down the ribs between adjacent gullies will effect worth-while economies. Black powder, free-running ammonia blasting dynamite and 40 per cent ammonia dynamite have been used. Low-velocity explosives are preferable to the earth moving usually encountered.

Treatment of a typical case

After a contract is made with the land owner and an estimate of the kind and amount of material available for check-dam construction is determined. the area is carefully studied by the engineer. From this study is determined the treatment to be used, placement of structures and the type of structure for each location. The type of work undertaken in this district is best illustrated by describing a typical case.

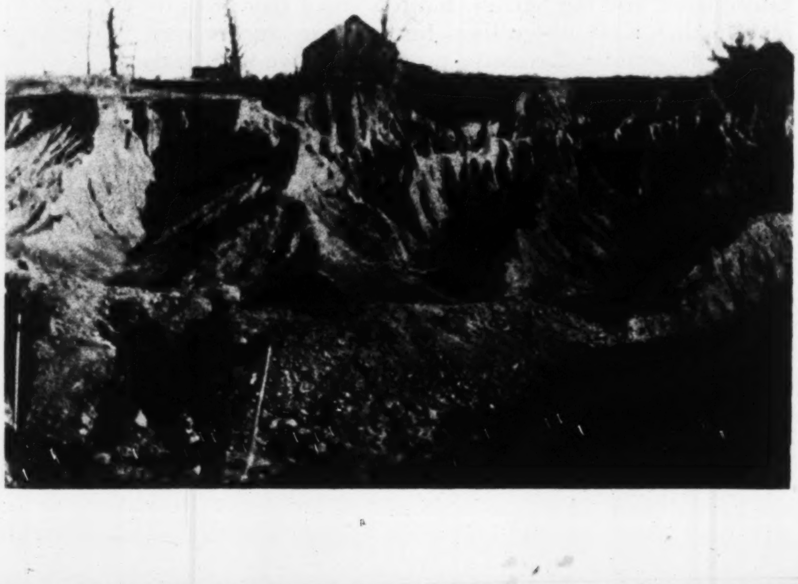


FIG. 3—TYPICAL GULLY EROSION which the CCC forces are trying to check.

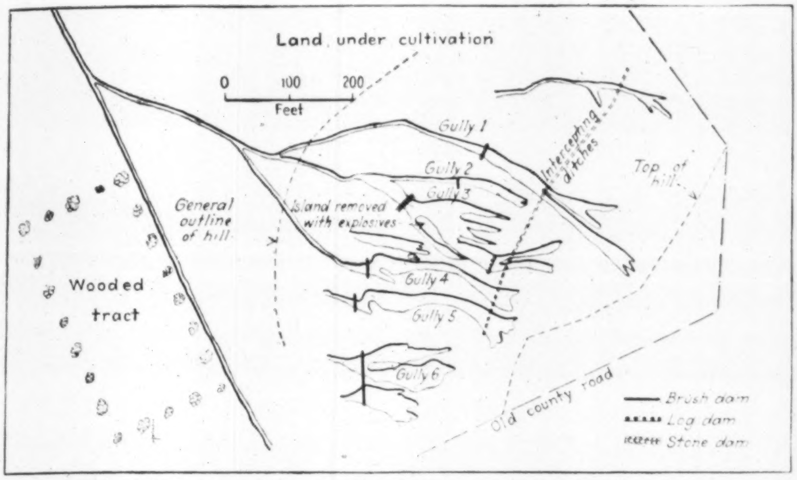


FIG. 4—MAP of a typical case of gully-erosion treatment. Several gullies are drained into one by means of intercepting ditches and a check dam built at the throat. Log dams are placed near lower ends of the other gullies.

This typical project lies in the basin of the Tradewater River and contains bottomland, "high bottomland" and hilly land. The large gullies shown in the map, Fig. 4, have developed in the last fifteen years solely through neglect and poor farming methods. The slope of the land averages 14 per cent. The deepest gully is about 13 ft., the remaining ones average 7 ft. in depth.

Intercepting ditches were installed to drain most of the gullies into gully No. 3, as shown in Fig. 4. These ditches are 1 ft. deep, 4 ft. wide at the bottom and have side slopes of 1½:1 on the low side and 3:1 on the high side. The excavation was cast on the low side to form a dike. The gradient on the bottom is 0.5 per cent, which has been demonstrated to be the grade below which erosion is negligible. At the junction of these ditches with gully 3, the bottom and slopes have been paved with riprap for protection. This riprap protection takes care of a 4-ft. drop from the ditches to the flow line of gully 3. The ditches enter gully 3 just above a substantial log dam 4½ ft. high. Considerably below the log dam a stone dam has been constructed in the throat of gully No. 3 (Fig. 2). This structure is 6 ft. high and 30 ft. long at the crest level, and is built of hand-placed loose stone masonry laid without mortar. The dam is backfilled with earth, and after very heavy rains it has proved to be watertight. A section of this structure is shown in Fig. 1.

Near the lower end of each of the remaining gullies was built either a log or a brush dam to retain material that may creep down after the banks were sloped for planting. With flow intercepted at the heads, this is felt to be ample treatment. Vegetation is assumed to hold the banks sufficiently before these silting basins have been filled.

The banks of each gully were graded down to permit seeding and planting. At first this bank grading was done entirely by hand, but was subsequently aided by the use of plows and scrapers to speed up the work. Applications from land owners far exceed the possible number of projects that can be completed with present forces, so equipment was introduced to make the work as widespread as possible.

On these projects the land owner does not relinquish title to the treated area, but the Commonwealth of Kentucky reserves the right to the timber grown on the reclaimed tracts.

Organization and personnel

There are about 200 men of the Civilian Conservation Corps in each erosion-control camp. About 150 workers in each camp are available for field work. These men are divided into work parties of about 25 men each, working under the direction of a forester foreman of the Kentucky State Forest Service.

All work on the project is under the general direction of W. E. Jackson, Jr., state forester and collaborator, U.S. Forest Service. All technical details of laying out work, inspecting construction and record mapping are handled by the writer.

Three New Bridges for Cape Cod Canal

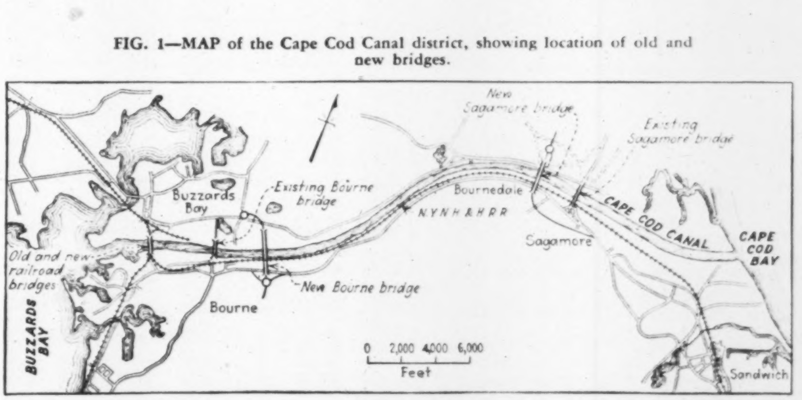
Start of construction follows close upon PWA allotment for two high-level highway crossings of three-span continuous type and a vertical-lift railroad span of record length

Under an appropriation to the U. S. Army Engineers from PWA funds, three large bridges are under construction across Cape Cod Canal in southeastern Massachusetts, two of them fixed continuous-truss highway crossings that will clear the canal 135 ft., and the other a vertical-lift railroad structure with a record lift span of 544-ft. length.

The new bridges will rank with the largest in New England and will replace three low-level structures that now hamper navigation, rail and highway traffic alike. An allotment of $4,600,000 was made on Sept. 14, 1933. Contract for design was at once let to private engineers, and the basic plans were rushed to completion. These were approved by the Boston district engineer, the North Atlantic division engineer, and the Chief of Engineers on Sept. 24, 1933.

Bids for the substructure of the highway bridges were advertised Nov. 4,

FIG. 1—MAP of the Cape Cod Canal district, showing location of old and new bridges.



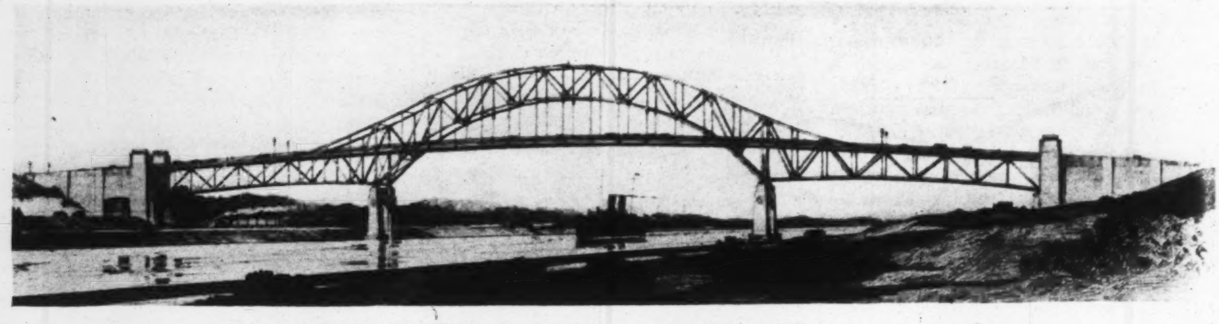


FIG. 2—ARTIST'S DRAWING of one of the two new highway bridges that will span Cape Cod Canal. This is the Sagamore Bridge; the Bourne structure is identical except for the addition of side spans. The main crossing is a three-span continuous truss with a center span of 616 ft. and flanking spans of 396 ft.

opened Nov. 20, and contract was awarded Nov. 27. Proposals for the railroad bridge foundations were advertised on Nov. 6, opened Nov. 29, and contract was awarded Dec. 5. The construction schedules call for all foundations to be ready for steel erection early this spring. Contract for the steel superstructure of the two highway bridges was awarded Jan. 6. Bids for the railroad bridge superstructure will be advertised shortly.

Highway bridges of graceful design

The two highway bridges will be located in the villages of Bourne and Sagamore, toward the western and eastern ends of the canal, respectively, and about 3 miles apart. The Bourne Bridge will be 3,235 ft. east of an existing bridge that it is to replace, and the Sagamore Bridge will be located 2,500 ft. west of a present bridge which it will replace. Both of the old structures are double-leaf bascule spans, the span length being too short adequately to pass the increasing number of boats now using the canal. Furthermore, they are low-level structures, causing frequent interference with highway traffic because of the numerous openings required.

For the main spans across the canal the two new bridges are identical in size and design. Though designed as a three-span continuous truss, the center span of the crossing rises in a graceful arch 270 ft. high to carry the bridge floor to a clearance of 135 ft. over mean high water for a distance of 500 ft. The center spans are 616 ft. in length, and the two adjacent continuous spans are 396 ft. long. These three continuous spans comprise the entire superstructure at the Sagamore Bridge, but the Bourne structure has four additional side spans of simple deck-truss design.

The trusses are spaced 51 ft. center to center. A 40-ft. roadway will be provided on each structure, flanked by one 6-ft. sidewalk. The floor structure will consist of I-beams carrying a 7-in. concrete slab, topped by a 2-in. bituminous wearing surface. Stepped curbs of a total height of 16 in. will keep traffic on the roadway. The center-span trusses rise above the roadway level, and over most of this span the roadway will be suspended by prestressed cables instead of rigid hangers. The entire roadway will be lighted, and an airway beacon will be provided on top of the center span at the highest point. The structures are designed for a 20-ton truck loading.

The four main-channel piers, two for each bridge, are identical in design and size except for a slight variation in height. The bases of the piers will be 108x50 ft. in plan and 25 ft. in thickness, resting on a compact gravel formation at an elevation from 52 to 54 ft. below sea level. Upon each monolithic base section will rise two shafts at each pier, each shaft being 32x32 ft. in plan at the bottom and tapering at the top. The upper 71 ft. of each shaft will be hollow. A granite facing will be placed around the shafts at water line.

All four abutments are hollow U-shaped structures with thin reinforced-concrete walls. A concrete T-beam deck will carry the roadway over each abutment. Because of the similarity of substructure on both highway bridges, bids were taken for both jobs together as one contract on a lump-sum basis. The only unit price asked for was that for extra concrete, in case the footings of any of the structures were carried below the depth originally contemplated, the cost of concrete to include the cost of extra excavation and shoring.

Record railroad span

The lift span of the new railroad bridge will be 544 ft. long, ranking it as the longest of this type of structure in the world. It will be located 60 ft. east of the old double-track bascule span which carries the Wood's Hole and Provincetown branches of the New Haven Railroad across the canal at the Buzzards Bay, or western end, of the waterway. The new structure will carry only a single track. Railroad traffic is now so light that the span will remain in the open position, clearing the channel 135 ft. above mean high water, except for passage of a train.

Much attention has been paid to the design of the new bridge from an esthetic standpoint. The top chord of the main span is slightly curved. The flanking spans are 128 ft. long. Some consideration was given to towers of reinforced concrete, but final plans designate the use of steel. Omission of all redundant members adds to the appearance. All operating machinery will be located in the towers, leaving the lift span free of an unsightly operating house. Submarine cables will take the place of the usual overhead wires across the span.

Two electric motors at the top of each tower will provide the operating power for the lift span. These will be geared to counterweight rope sheaves. Two 10-in. rope sheaves will be placed at each corner of the span. If the usual bronze bearings are used in all sheaves, the size of the motors will be 250 hp. Consideration is being given to the use of roller bearings throughout, capable of handling 300-ton loads each, which would reduce the size of the motors to 150 hp. The unbalanced weight of the counterweight ropes will be compensated by auxiliary counterweights hanging above the main counterweights. A storage battery and an auxiliary gas-engine generator unit will be installed for emergency operation.

The towers will rest on masonry piers, each having a monolithic base 44x88 ft. in plan, 25 ft. thick, with bottom resting at an elevation 62 ft. below mean sea level. The pier shafts, 44 ft. high, are 18x68 ft. at bridge seat level, tapering outward on a ½-in. to 1-ft. batter toward the base. Because of their depth it is expected that the construction of the railroad bridge main piers will be the most difficult part of construction of all three projects. The abutments for the railroad bridge rest on bases 46x22 ft. in plan, carried to an elevation 20 ft. below sea level. Granite facing is provided at water line on abutments and piers.

Canal improvements

The Cape Cod Canal, opened in 1914, has had a long and interesting history. It was considered for more than two centuries before actual construction began. The first official recognition of the need for the canal was in 1697.

when the General Court of Massachusetts ordered a report made. Work was actually started on the cut in 1883, when about a mile of canal was excavated. In 1899 a charter was granted to the Boston, New York and Cape Cod Canal Co., with amendments to this charter being made in 1900 and 1910. Construction was again commenced June 19, 1909, utilizing the previous excavation. Removal of 15,000,000 yd. of material was required before the job was finished. The site of the canal is a glacial terminal morain, consisting of sand, gravel and granite boulders.

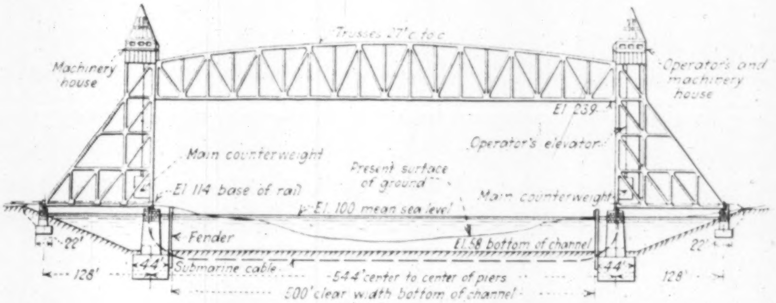


FIG. 3—THE RAILROAD BRIDGE over the canal will be the longest vertical-lift span yet built, 544 ft. c. to c. of piers.

The original construction provided a waterway 7.7 miles long across land and an additional 5.3 miles of sea channel, with a minimum bottom width of 100 ft. and a minimum depth of 25 ft. The canal was purchased by the federal government under the Rivers and Harbors Act of Jan. 21, 1927, at a capital cost of $11,500,000. The government took possession March 31, 1928. Traffic through the canal has increased rapidly in the past few years, now amounting to 10,000,000 gross tons of shipping annually.

Variable and non-synchronous tides exist at each end of the canal. At the Cape Cod Bay end the mean tidal range is 8.9 ft., and at the Buzzards Bay end the range is 3.6 ft. This creates a reversing current of 4 to 7 miles per hour velocity. Because of this tidal current and the narrowness of the waterway, the canal has long been a one-way channel; that is, there is no room for large vessels to pass within the land section. The federal government is now widening the canal to 170 ft., with a minimum depth of 25 ft. Half of this widening operation has been completed, and the other half is under way at present. Before the canal without locks can be used as a two-way waterway for larger vessels, it will be necessary to widen it out to at least 300 ft. and deepen it to 30 ft. The government hopes to start widening and deepening to 250 ft. in the near future. A logical subsequent step in improving the canal would be to widen it to 400 ft. and possibly to install twin locks at one end 110 ft. wide and 1,000 ft. long, with 40 ft. of water over the sills. Opinions differ as to whether locks would be necessary if the canal were widened to 400 ft. The widening will increase the tidal current, but with more room available, boats might be able to navigate safely. If so, the trouble and expense of installing and operating the locks would be unnecessary.

The present 170-ft. widening program was adopted Aug. 20, 1932. An allotment of $277,000 was made to widen the canal to 170 ft. from the east entrance to Bournedale. Subsequently a second allotment of $316,500 to continue dredging operations and remove boulders from the channel between Bournedale and the western end of the canal was made. This work is now in progress.

Old bridges

At the time of construction of the existing bridges, widening the canal was evidently considered, for the channel draw spans were built 160 ft. from center to center of pier, although the canal is only 100 ft. wide, and pier construction permitted deepening to 30 ft. The present need for widening and the desirable elimination of troublesome delays to all traffic by operation of the old bridges prompted the government to go ahead with the new bridge program. Since it is not known at this time what the future development of the canal will be, provisions are being made in the new structures for a possible 500-ft. width of canal and a depth of 40 ft.

The old railroad bridge is an electrically operated, single-leaf trunnion bascule, clearing mean sea level by only 12 ft. The substructure consists of three piers only, the approaches being pile trestles. The piers were founded on wooden piles. The structure carries two tracks between trusses spaced 29.6 ft. c. to c.

The two existing highway bridges are double-leaf bascules, 160 ft. c. to c. of piers, and are of the Scherzer rolling-lift type. The piers were not faced with stone, but creosoted form lumber was left on the exposed faces at water line, which has proved to be adequate protection. The piers are founded directly on gravel, and no piles were used. They were constructed by the pneumatic-caisson method.

Besides the 160-ft. main span at Bourne, this structure contains two 90-ft. truss side spans and three additional 40-ft. and six 38-ft. flanking spans. The Sagamore Bridge was similar to the Bourne structure, except for the nine additional flanking spans.

Engineers and contractors

All plans for the structures were prepared under the direction of Lieut-Col. Richard Park, district engineer, Boston district, U. S. Engineer Corps. This office will also supervise construction. Plans for the two highway structures were prepared by Fay, Spofford & Thorndike, consulting engineers, Boston. Cram & Ferguson, Boston, were consulting architects in the preparation of the highway bridge design. The railroad bridge was designed by Parsons, Klapp, Brinckerhoff & Douglas, consulting engineers, New York. McKim, Mead & White, New York, were consulting architects on the design of this structure. The contract for the substructure of both highway bridges was let to P. J. Carlin Construction Co., New York, for $1,327,700. C. W. Blakeslee & Sons, New Haven, and Blakeslee-Rollins Corp., Boston, received the contract for the substructure of the railroad bridge, amounting to $317,500. Superstructure for both highway bridges was awarded to the American Bridge Co. for $1,444,730.

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New Highways Planned for Buenos Aires Province

A COMPREHENSIVE highway-construction program for the Province of Buenos Aires, Argentina, involving the expenditure over a period of five to fifteen years of 180,000,000 paper pesos was recently approved by the federal government national highway bureau. (Par value of paper peso equals $0.4245, U. S. currency.) The total amount will be distributed in more or less equal parts over three zones of the province, one being the neighborhood of the city of Buenos Aires, and the other two the northern and southern zones of the province.

The project calls for the construction of a total of 5,039 km. of highways, of which 1,921 will be paved, 2,553 improved and 785 ordinary dirt roads. The provincial government at the same time will undertake to construct roads totaling 20,000 km., consisting chiefly of short roads giving access to various towns and to main roads.

Congestion now existing on roads giving access to the city of Buenos Aires will be relieved by the construction of new highways in this area. Work on the Avenida General Paz will be completed, for which purpose 40 per cent of the proceeds of the gasoline tax in the capital will be appropriated.

Long Continuous-Girder Bridge of Concrete in Kansas

Single unit, 450 ft. long, includes five shallow-deck spans from 70 to 110 ft. long—Extensive channel relocation involved

By LaMotte Grover
Office Bridge Engineer,
Kansas State Highway Commission, Topeka, Kan.

A STRONG local preference for concrete-deck-type construction led to the adoption of a rather unusual design for a bridge across the Big Blue River at Marysville, Kan., built as an emergency federal-aid project. Characteristics of the river required span lengths greater than commonly used for concrete-deck girder construction. The short distance from city improvements limited the height of grade and necessitated a shallow-deck structure. The provision of a pleasing appearance was also a major consideration.

The design adopted consisted of a single unit of five continuous reinforced-concrete spans of 70-ft., 110-ft., 100-ft. and 70 ft. consecutive lengths, the piers being founded upon rock. The roadway width is 24 ft. The total depth of the deck is 3 ft. 8⅝ in. at the middle of each span and 8 ft. 8⅝ in. at the piers. The shallow depth is accomplished by the provision of compressive reinforcing steel throughout and also by using a soffit slab (Fig. 3) in the regions of high negative moment, where the girders are then assumed to act as wedge-shaped T-beams with compressive reinforcement. A built-up, welded, structural-steel segmental roller is provided under each girder on all the piers except the one under the fixed rocker bearings, which are made from structural-steel slabs. Economical abutment design is aided by using rollers under only the exterior girders, the reactions from the interior girders being carried to these rollers by a transverse concrete diaphragm beam.

As a part of the project, an extensive river channel location was undertaken, as shown in Fig. 2. The bridge, as a matter of fact, was built on land, and the river was then diverted under it. The low-cost method of excavation and the stocking of much of the excavated material for use as concrete aggregate and road-surfacing metal, together with the use of other excavated material in building the approach fills to the bridge, economically justified the relocation of the channel solely upon its merits as a part of the highway improvement, despite the cost incurred in making necessary extensions to the intake of the city water system and to the outlet of the sewerage system. A saving in the length and cost of the bridge also resulted, and the flood hazard to the city was reduced considerably from what it would have been if the bridge had been built across the existing natural channel.

The bridge is designed for a standard H-15 loading with basic stresses of 900 and 18,000 lb. per sq. in., respectively, for concrete and reinforcing bars, with the further provision that a 100 per cent increase in live load and impact will not cause stresses in excess of 1,200 and 24,000 lb. per sq. in. Two methods, one entirely analytical and the other largely graphical, were used in computing the moments, shears and reactions, one being used as a check against the other. The first analysis was by the method described by Walter Ruppel in his discussion of the paper "Moments in Restrained and Continuous Beams by the Method of Conjugate Points," by L. H. Nishkian and D. B. Steinman (*Trans.,* Am.Soc.C.E., Vol. 90), the values of the beam constants being taken from the tables for Case I, sharply curved haunches. The second analysis was by the method presented by Hardy Cross in the paper "Analysis of Continuous Frames by Distributing Fixed End Moments" (*Trans.,* Am.Soc.C.E., Vol. 96), the beam constants being determined as outlined in the discussion of this paper by George E. Large. The moments of inertia used in these analyses were of the entire concrete section, neglecting the reinforcing steel.

No serious difficulties were encountered in the construction. Serrated construction joints (Fig. 3) were provided between the soffit slab and the girders. Step-cut vertical construction joints were used in the girders (Fig. 3), and additional reinforcing bars were provided at these points in a diagonal position, to tie the joints securely together.

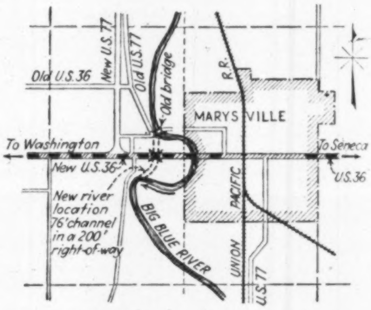
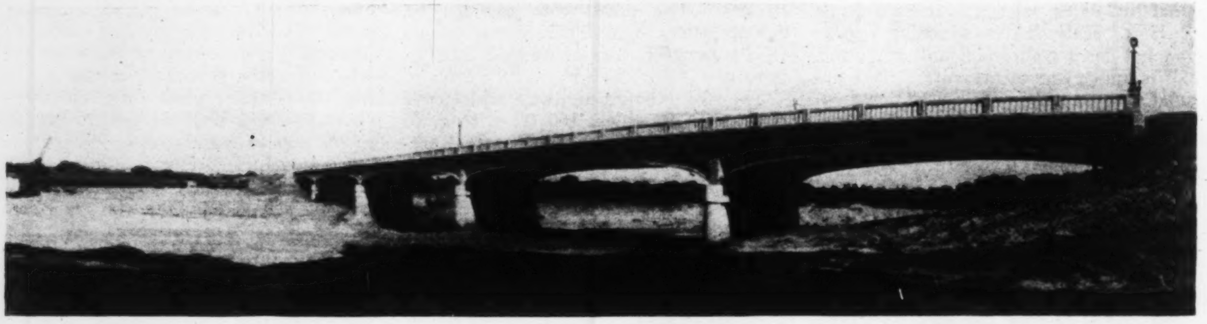


FIG. 2—BRIDGE LOCATION, showing river channel change and new highway route through city.

A double curb was provided similar to the type used for the Seventh St. Trafficway — Kansas River Bridge (*ENR,* Oct. 19, 1933, p. 459). It was found necessary to place this curb after the removal of the falsework in order to avoid the formation of small vertical cracks in the curb through the regions of negative moment in the girders.

Because of the unusual length of integral concrete construction involved, the use of crushed-stone coarse aggregate was specified, in order to reduce shrinkage tendencies; graded, sand-gravel, combined aggregate has been used in

FIG. 1—FIVE-SPAN, continuous concrete-girder bridge at Marysville, Kan., in which total depth of deck at center of 110-ft. span is 3.75 ft. River was diverted into new channel under bridge after structure was completed.



the state for many years in all ordinary highway structures, but was not considered suitable for this job.

In excavating the channel the loamy topsoil was stripped from the underlying gravel and used in constructing the bridge approaches. Most of the 25,000 cu. yd. of gravel excavated from the channel was stocked for future use. A total of about 141,000 cu.yd. of channel excavation was involved.

Provision was made at one of the central piers for housing an automatic water-stage recorder by the U. S. Geological Survey. A shelter house was formed between the center girders of the deck (Fig. 3), and a well was constructed within the web of the pier. Access to the shelter house is through a manhole in the floor-slab of the deck. A new water-supply intake was also built adjacent to one of the piers.

The total cost of the bridge was $48,500, or about $108 per linear-foot. The net cost of making the channel change and constructing 2,500 ft. of approach grade with part of the material excavated was about $20,000.

The bridge was designed in the office of the state highway commission, by George L. Epps and E. S. Elcock, under the direct supervision of the writer and the general supervision of O. J. Eidmann, engineer of design. Rollin J. Smith was in charge of road design. W. V. Buck is state highway engineer.

The bridge was constructed by the Koss Construction Co., Des Moines, Iowa, and the earthwork was handled by Reed & Wheelock, Clay Center, Kan. The engineering supervision was by H. D. Barnes, engineer of construction of the state highway commission, with Thos. E. Burton, R. K. Dinklage and S. B. Quantz as division engineer, assistant division engineer in charge of construction and resident engineer, respectively.

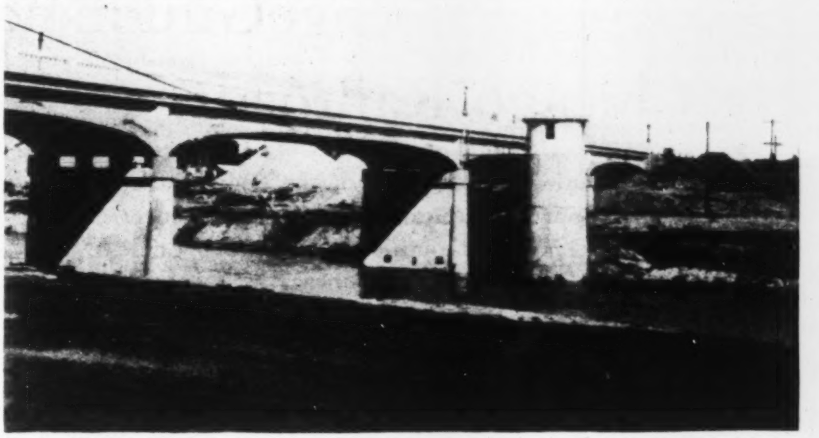
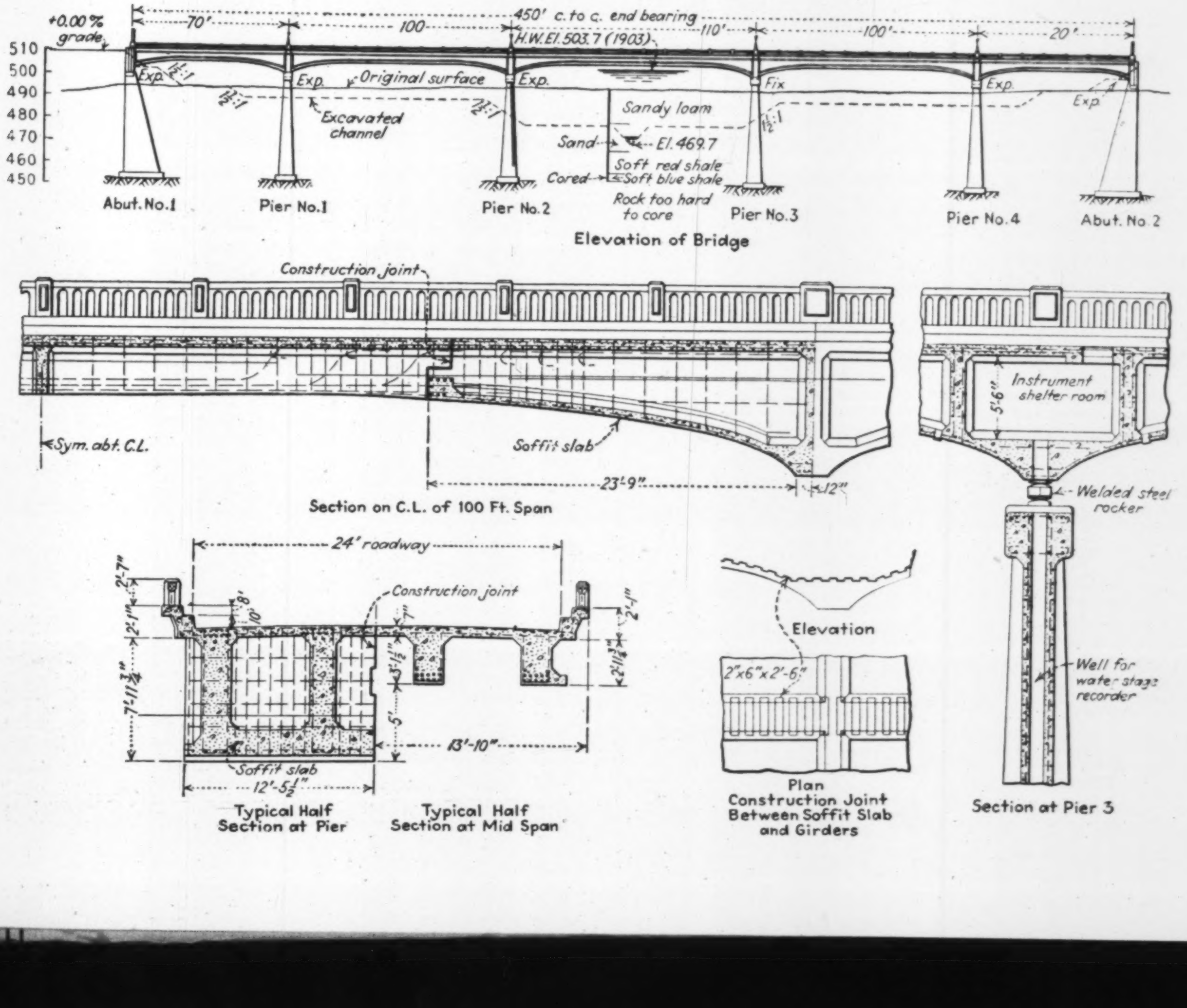


FIG. 4—NEW RIVER CHANNEL under bridge running almost bankfull. City water-supply intake, adjacent to pier, had to be built when river was relocated.

FIG. 3—STRUCTURAL DETAILS of five-span, single-unit, concrete-girder bridge. Shallow depth at center of spans is achieved by use of soffit slabs to resist high negative moments either side of the piers. Note facilities in pier 3 for river-gaging equipment.



+0.00% grade
510
500
490
480
470
460
450
70'
100
450' c. to c. end bearing
H.W. El. 503.7 (1903)
110'
100'
70'
Exp.
1½:1
Original surface
Excavated channel
Fix
Sandy loam
Sand
El. 469.7
Soft red shale
Cored
Soft blue shale
Rock too hard to core
Abut. No. 1
Pier No. 1
Pier No. 2
Pier No. 3
Pier No. 4
Abut. No. 2
Elevation of Bridge
Construction joint
Sym. abt. C.L.
Soffit slab
23'-9"
12"
Section on C.L. of 100 Ft. Span
Instrument shelter room
5'-6"
Welded steel rocker
24' roadway
2'-7"
2'-1"
10"
8"
7"
Construction joint
2'-1"
2'-1½"
3'-1½"
7'-11¾"
5'
13'-10"
Soffit slab
12'-5½"
Typical Half Section at Pier
Typical Half Section at Mid Span
Elevation
2"x6"x2'-6"
Plan Construction Joint Between Soffit Slab and Girders
Well for water stage recorder
Section at Pier 3

Lakefront Passenger Terminal for Chicago Railroads

Impediment to southward expansion of the Loop district proposed to be removed by consolidation of all passenger services of the several depots south of the district in a new station adjoining East Randolph St. near the lakefront

IN ACCORD WITH the spirit of the federal legislation passed recently by Congress calling for coordination of railroad operations in the United States, the city of Chicago, through its railway terminals committee, has put forward a plan for the consolidation of passenger terminals which will be beneficial to the city and at the same time will enable the railroads to enter into a consolidated operating program that will result in material savings in operating costs. The plan is contained in a report submitted to Mayor E. J. Kelly in December. It calls for the concentration of all the passenger facilities of the existing Grand Central, LaSalle St., Dearborn and Illinois Central (12th St.) stations in a new station fronting on E. Randolph St. near the lakefront on property now owned by the Illinois Central. This proposed arrangement would permit the business or Loop district to develop to the south into an area now largely occupied by the railroads. The cost, estimated at $19,000,000, is the least of any of the many schemes put forward during the past twenty years.

The city council's committee on railway terminals, in its report from which the following notes are taken, undertook to analyze the economic and operating problems as they now exist and to determine the benefits that would accrue to the general public and the railroads after consolidation and relocation of their passenger terminals at some point that would permit a more logical development of the business district of the city than is possible under present conditions.

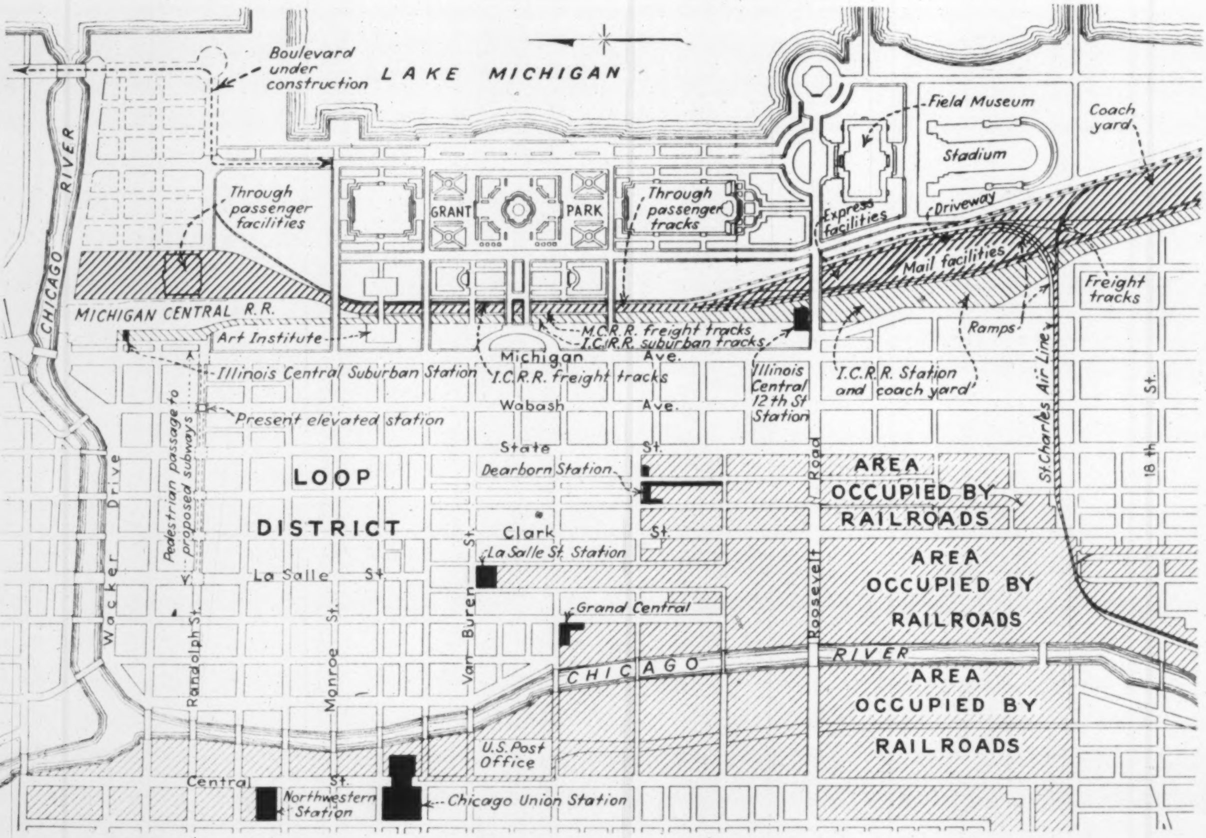
Passenger-terminal development

The history of the development of the railway passenger terminals at Chicago, according to the report, shows clearly that the controlling motive in the selection of a site for a terminal was the desire to secure a location as near as possible to the business center of the city.

The original plans submitted to the city for approval by the Illinois Central Railroad, provided for a line along the east bank of the South Branch of the Chicago River and the location of a passenger terminal near the main stem of the river with a possible connection with the Northwestern. But the desire of the city to be relieved of the burden of protecting the shore of Lake Michigan resulted in the Illinois Central's being forced to accept a location along the lakefront. Its terminal was located north of Randolph St., the main east and west street nearest the river.

There was a time in the history of the city when the trend of business indicated a substantial expansion of the business section southward, and numer-

CENTRAL BUSINESS DISTRICT of Chicago, showing the existing passenger stations and the areas now occupied by the railroads south of the Loop district, also the proposed new passenger facilities adjoining the Illinois Central facilities east of Michigan Ave.


Boulevard under construction
LAKE MICHIGAN
Field Museum
Coach yard
Stadium
CHICAGO RIVER
Through passenger facilities
GRANT PARK
Through passenger tracks
Express facilities
Driveway
Mail facilities
Freight tracks
MICHIGAN CENTRAL R.R.
Art Institute
M.C.R.R. freight tracks
I.C.R.R. suburban tracks
Ramps
Michigan Ave.
Illinois Central Suburban Station
I.C.R.R. freight tracks
Illinois Central 12th St Station
I.C.R.R. Station and coach yard
Wabash Ave.
Present elevated station
Pedestrian passage to proposed subways
State St.
Dearborn Station
LOOP DISTRICT
AREA OCCUPIED BY RAILROADS
Clark St.
La Salle St. Station
La Salle St.
St. Charles Air Line
18th St.
Roosevelt Road
Wacker Drive
Randolph St.
Monroe St.
Van Buren St.
Grand Central
AREA OCCUPIED BY RAILROADS
CHICAGO RIVER
AREA OCCUPIED BY RAILROADS
U.S. Post Office
Central St.
Northwestern Station
Chicago Union Station

ous plans have been suggested from time to time for the location of terminals in keeping with this development. However, today terminals located near the main stem of the Chicago River would seem to fit best the recent commercial development of the city and would be in keeping with the requirement that passenger terminals should be close to the heart of a city.

The report holds that there can be no question but that the present location of railroad passenger terminals and the curtailment of adequate through streets south of the Loop district have been the barrier to the natural expansion of commercial development southward. This has forced business and residential development northward across the Chicago River as evidenced by the building activity during the past ten years in the area north of the Chicago River along North Michigan Ave. and then east.

For more than twenty years every city administration has persistently sought to bring about a relocation of the passenger terminals in the South Side terminal area. Continuously during this period the city officials and the railway terminal committee of the city council have held meetings in an effort to bring about a relocation of these passenger terminals or at least some consolidation of them that would permit the opening of additional north and south streets through this area, but no satisfactory plan has been developed. In view of this the railway terminals committee turned to consideration of proposals to consolidate the passenger terminals on the lakefront, and they find the following advantages, as compared to a station located south of the Loop district:

A passenger terminal on the lakefront is accessible to all parts of the city by street-car and elevated lines. The Outer Drive Boulevard and Michigan Ave., by reason of a minimum of cross-traffic and freedom from slow-moving vehicular traffic, render this location especially accessible for taxicabs, motor buses and private vehicles.

It would be as accessible by automobile, taxicab or bus transfer to the Union and Northwestern stations as any of the sites south of the Loop district.

There would be less congestion in street traffic going to and from a passenger terminal on the lakefront than to any site that can be chosen south of Van Buren St. and west of State St.

It would not require the construction or maintenance by the railroads of the costly system of viaducts that will be necessary at any of the other proposed sites.

The construction of comprehensive depot facilities on the lakefront will not in any way interfere with the growth of the business area of the city. In fact, it will remove congestion from the business area.

It would not in any way interfere with or obstruct the street system of Chicago, but would add to that system; if used by all the other roads now using South Side stations, it would permit of the opening of many South Side streets.

It is removed from the immediate vicinity of any freight terminal, thus keeping the entrance to and from the station away from those streets on which there is slow-moving traffic.

It would be located on the inner circulatory system of wide streets recommended in the original Chicago Plan—Michigan Ave., Roosevelt Road, Canal St. and Wacker Drive.

A passenger terminal on the lakefront is in conformity with the Chicago plan.

The cost is far less than at any other site available west of State St. and south of Van Buren St.

It would eliminate from streets the transfer of passengers, baggage, mail and express between the railroads now using the four stations and would thereby reduce street congestion and traffic. All transfers to and from the Union and Northwestern stations can be made on streets outside of or at the extreme edge of the Loop district. This will lessen Loop traffic and congestion accordingly.

Available site

East Randolph St. as a site is now available because the Illinois Central in recent years has removed its large produce-freight business to a produce terminal at 31st and Ashland Ave., where it now serves the new South Water St. market. The old market gave way to the double-deck Wacker Drive. Trucks have made further inroads in the small package-freight business handled here. The changes have developed a situation whereby the Illinois Central is now using only part of the large area of valuable property north of Randolph St.

Should the several railroads now using passenger terminals located south of the Loop transfer their passenger operations to a consolidated passenger terminal at Randolph St., there would then need to be provided in the railroad-occupied territory south of the Loop only facilities for handling less-than-carload freight. Such freight-handling facilities could be consolidated in the area west of Clark St., thereby making the area east of Clark St. available for unrestricted commercial development.

The report further points out that in connection with the movement toward store-door delivery there seems to be an opportunity for the development of a system of handling l.c.l. freight in large metropolitan areas like Chicago that will result in substantial savings to the railroads without additional cost to the shipper. If such a system were placed in operation, it would no longer be necessary to maintain the present costly individual freight houses close to the congested area of the city.

Because of the fact that the Grand Central, La Salle St. and Dearborn stations are located in congested areas, it becomes necessary in the operation of these stations to provide coachyard and engine terminal facilities in locations miles distant from the passenger terminal. This means that the railroads using these terminals have to move passenger-train equipment and engines, in most cases, 3 to 5 miles from the station.

If the passenger services are consolidated into one terminal at Randolph St., the coachyards and engine terminals can be located slightly over a mile distant from the passenger terminal. The movement from the terminal to the coachyard and engine terminals will be over tracks used exclusively for passenger-train movements. They can be increased sufficiently in number to provide free-running tracks for this movement.

Mail and express facilities

If the passenger stations south of the Loop and east of the river are consolidated into one terminal at Randolph St., it will be possible to provide mail and express facilities south of and immediately adjacent to Roosevelt Rd., at which point the road engine and the mail and express cars can be disconnected from the train and the rest of the train pushed into the station. Motive power used for serving the area between Roosevelt Rd. and the station would be of some type other than steam locomotives.

Savings and costs

Savings based on 1932 business, admittedly low, are estimated at 50 per cent of costs for similar services at existing stations.

It is estimated that the proposed terminal, constructed according to the plans attached to the report, including stations, tracks and platforms, station facilities, viaducts and ramps, can be constructed for $15,500,000. The rearrangement of tracks between the proposed terminal and Roosevelt Rd. and the construction of mail-express and coachyard facilities will cost $3,500,000, making the total cost, exclusive of land, $19,000,000.

In the rearrangement proposed in the report an effort has been made to provide connections between the tracks of the several railroads and those of the Illinois Central at points where there will be a minimum of interference with existing facilities. Improvement in the route will be made wherever possible. In general, all railroads from the west and the Rock Island and New York Central are taken in over the St. Charles Air Line. In all other cases the railroads are connected where their present routes intersect the existing lines of the Illinois Central.

The plan here outlined was prepared for the railway terminals committee of the city council by the consulting engineer, Edward J. Noonan.

Simple Apparatus for Testing Cement Characteristics

Describes an inexpensive testing device for making practical heat-of-hydration and volume-change determinations—Tests made with the device indicate wide range of characteristics in commercial cements

By S. C. Pierce and H. McC. Larmour

Chief Engineer and Chief Chemist, Respectively, Yosemite Portland Cement Corp., Merced, Calif.

INCREASING INTEREST among engineers and users of cement in the factors of heat of hydration and volume change and their effect on the characteristics of the resulting concrete has emphasized the importance of tests for these properties. From the point of view of the engineer it is desirable to be able to evaluate the relative merits of various cements on the market for the particular work to be done; the manufacturer is equally interested in the important problems of the effect of materials and handling which control these same characteristics.

To be of practical value, in either case, the tests for the value of these properties, with accuracy suitable for comparative results, should be based on methods and use of equipment that are relatively inexpensive as to cost and operation. Existing apparatus is generally expensive and elaborate. The present article describes apparatus that is simple, inexpensive and has proved to give results suitable for reasonable comparisons. Further, results of tests are given to show the variation in these properties between commercial cements that are quite similar in chemical characteristics. The results indicate that for meeting conditions of service and use, specifications and studies of properties should be directed with increasing emphasis to the properties desired, rather than to chemical composition.

The original purpose of the tests made in this investigation was to secure information of interest to the manufacturer on the effect of composition and manufacturing processes on the resulting product. The important factors to be studied were: strength, heat of hydration and volume change. In addition, surface area, time of set and other routine determinations were made, but these were considered mainly as control properties.

Various strength tests were considered, and the conclusion was reached that engineers and users of cement desired concrete principally to resist compression. For this reason the compressive strength of cement is considered to indicate its strength performance, and a 1:3 mortar test was adopted, using graded sand of fineness modulus 2.80 and water to give a ratio of 0.85 by volume after correcting for the absorption of the sand. The resulting mortar is plastic, and while it does not equal concrete of similar design in strength, a mathematical ratio may usually be established. The 2x4-in. cylinder used permits many tests to be made at a small cost.

For heat of hydration, research laboratories had developed elaborate equipment for the determination of precision results. This type of work is valuable, but the cost of the necessary equipment and the expense of operation makes it prohibitive for the ordinary cement producer and user. As a result, the problem was to develop test methods that would involve small cost and permit a wider range of investigation with acceptable precision.

In volume-change investigations also precision equipment is required under the usual practice of measuring linear changes, as these changes are rather minute; but by measuring change of volume rather than of length, the changes become larger and are more easily measured.

Heat of hydration

The heat-of-solution method seemed most promising for determining the heat of hydration property of cement. Numerous research laboratories have reported success with this method, and it can be assumed that its principle of taking the difference in heat of solution between hydrated and unhydrated samples is well established. Such precision tests have indicated that different cements differ by more than 100 per cent, but that differences of 10 per cent are of little consequence from a construction standpoint in most cases. Therefore, an accuracy of 3 or 4 calories per gram was considered sufficient for the present study.

A 10 per cent solution of hydrochloric acid was adopted as solvent. This solution does not dissolve the material completely, but acts on more than 90 per cent of any portland cement. The degree of solution may be easily checked by filtering the residue and igniting and weighing. Hydrochloric acid has the advantage over the usually used hydrofluoric acid that an ordinary glass cup will resist its action and a glass thermometer may be used for the determination.

Apparatus—The accompanying illustration (Fig. 1) shows the apparatus. The cup is an ordinary 1-qt., open-mouth thermos bottle mounted on a vertical shaft and driven through a pulley attached to the bottom by a small electric motor with speed reducer. Temperatures are measured with a Beckman differential thermometer. Stirring is accomplished through the rotation of the cup; a loose glass rod rests in the cup, and as the cup turns the rod is rotated in the opposite direction.

The cup is rotated at 36 r.p.m. The only precautions necessary in determining the stirring rate are that the material shall be agitated violently enough to cause complete solution in a short time and not sufficiently to generate heat.

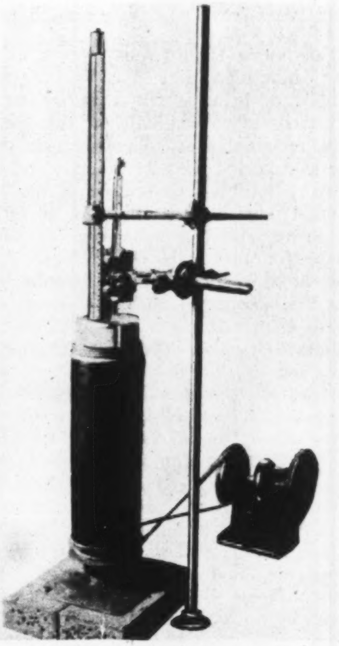


FIG. 1—HEAT-OF-SOLUTION test apparatus uses a 1-qt. thermos bottle rotated by a small motor; a differential thermometer and a stirring rod complete the equipment.

Heat-of-solution constants for various salts in fixed amounts of solvent are readily available in handbooks. Three such solvents and salts were selected and determinations made of heat of solution, which gave a basis for determining the heat constants of the calorimeter, the difference between the known and observed values representing the heat capacity of the instrument.

Testing Procedure — Three hundred grams of the 10 per cent solution of hydrochloric acid is introduced into the calorimeter cup, and the thermometer bulb is immersed to about half-depth. The stirrer is adjusted to rest on the bottom of the cup. The calorimeter is then rotated and temperature readings taken at 1-min. intervals. Usually, if a large stock bottle of the acid solution

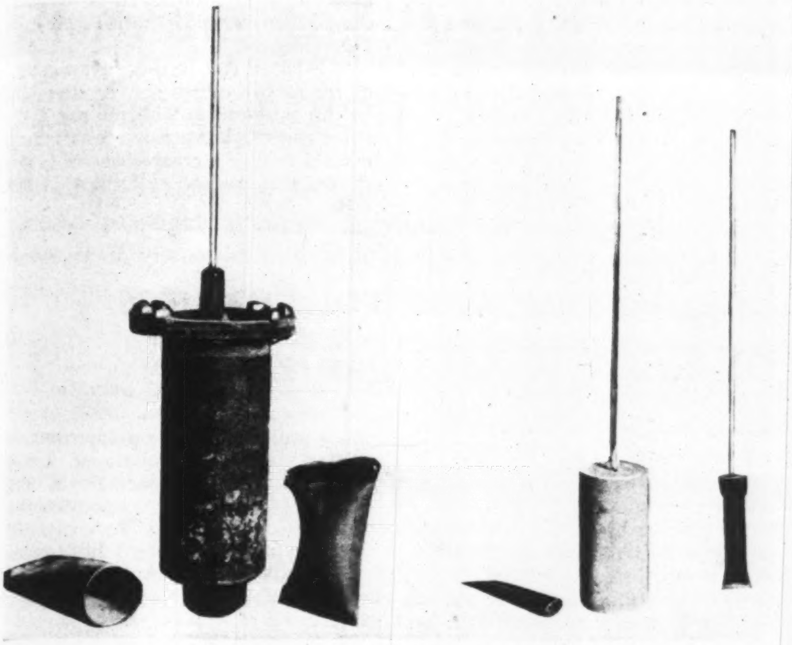


FIG. 2—EQUIPMENT for volume change is based on use of sections of rubber tube.

is used and stored in the room with the calorimeter at a fairly constant temperature, no radiation is noted after 2 or 3 min. stirring to equalize the temperature of the system. If radiation is evident, its rate must be determined by frequent readings for 4 or 5 min.

The cement, clinker or hydrated material, is then introduced into the system and temperature readings are taken until a maximum is reached; a few additional minute-interval readings are taken to check radiation further. The corrected rise in temperature is noted for calculation of heat of solution. The residue in the calorimeter is filtered, ignited and weighed. Ignition loss is determined on the sample under observation. The observed rise in temperature is then corrected to a dry basis from the ignition-loss figures and to a soluble-material basis from the results of the determined residue. This corrected figure is multiplied by a constant from the system, and a result representing the heat of solution is obtained.

As previously noted, the heat of hydration for a given time interval is the difference between the heat of solution of the original material and that of the material hydrated for the same period of time (usually 1, 3, 7 and 28 days) at the desired water ratio.

Cement or clinker under test may be hydrated with any desired water ratio for any desired time, and cured under any desired condition of temperature. The results quoted in the accompanying table were hydrated with 40 per cent water and cured in a sealed glass tube for the specified period at 70 deg. F.

The sample used should be large enough to produce a heat rise of 1 deg. C. or more, and at the same time small enough to stay within the range of the differential thermometer. The practice was to use 1 to 2 grams for original materials and 1½ times as much hydrated material. It was found that check determinations could be made on the same sample with an accuracy of 3 cal. per gram, and that the results obtained by precision instruments could be checked with about the same degree of accuracy.

Volume change

Volume-change determination for the present purpose is divided into two types of test: (1) where the cement or concrete is exposed only to the water used for tempering the cement; and (2) where conditions may be changed from wet to dry at will for observation purposes.

For a test under the former condition, using a neat paste of any desired consistency or concrete of any design, a rubber container is used for the concrete or paste so that it will conform to movement in the entire mass. Sections of automobile inner tube have been found convenient. The concrete is placed in a tube section that has previously been vulcanized shut at one end, and the other end is closed with a metal clamp in such a way as to exclude all air. The density of the concrete is determined by weighing a unit volume molded in a similar manner as that used for the test in the container. The mass of the container and clamp is known, and the mass of the filled container is determined. It is then simple to determine the volume of the concrete under test. Other methods of determining the original volume, involving water displacement of the specimen, are available.

After the specimen is prepared it is placed in the metal container shown in Fig. 2. The container is then closed watertight, and the stopper with the marked glass tube is inserted in the nipple at the top. The entire vessel is filled with water up to the reference mark A on the glass tube. Observations are made at desired intervals, either adding or removing water to bring the level to the reference mark as the concrete shrinks or expands. The added or removed water is measured with a burette or equivalent measuring device. Resulting volume changes are then corrected to an arbitrarily selected stand-

SOME TEST DATA ON PACIFIC COAST COMMERCIAL CEMENTS

Chemical Analysis

No.	C_4AF	C_3A	C_2S	C_3S	MgO	SO_3	Loss
1	8.48	7.39	22.94	51.69	2.79	1.59	1.57
2	7.27	12.61	22.97	48.92	1.50	1.78	1.39
3	8.42	8.37	20.40	54.38	1.78	1.53	1.41
4	6.23	11.82	20.97	53.03	1.98	1.55	1.63
5	7.54	8.93	21.39	51.12	4.04	1.71	1.10
6	7.45	8.22	20.62	52.83	3.69	1.60	2.01
	7.57	9.56	21.52	51.49 = Averages			

Compression Strength Tests

	A.S.T.M. Standard				Laboratory Mortar 1:3 mix		2.80 f.m. sand	
No.	1 Day	3 Day	7 Day	28 Day	1 Day	3 Day	7 Day	28 Day
1	955	1.846	2.228	3.756	441	1,592	2.809	4,446
2	891	2.292	3.247	3.565	509	1,910	3.247	5.555
3	255	1.010	1.910	4,138	318	1,719	3.119	4.775
4	828	2,546	3.518	4.430	446	2,005	3.483	5.157
5	962	2,419	3.115	4.647	446	1,592	2.817	4.393
6	764	2,355	3.182	4.902	382	1,464	3.055	4.138

Volume Change

	Alternate Wet and Dry (Arbitrary Comparative Unit)				Mass Curing (Arbitrary Comparative Unit)			
No.	Wet	Dry	Wet	Dry	1 Day	3 Day	7 Day	28 Day
1	2	27	15	10	15.6	18.7	22.2	28.4
2	4	26	27	32	18.5	30.4	37.8	43.1
3	7	24	26	22	17.0	30.4	35.9	40.5
4	1	4	7	14	18.7	31.4	36.6	41.8
5	6	22	21	21	19.6	33.8	36.5	40.0
6	6	12	11	21	16.4	25.6	28.3	32.2

Heat of Hydration

Mass Curing		Cal/Gram	
1 Day	3 Day	7 Day	28 Day
30	42	68	72
31	51	81	91
34	58	76	79
33	54	75	93
26	63	78	93
37	66	71	89

ard volume for comparative purposes. If desired, they may be changed to give percentage results, or the cube root may be obtained to give linear values. The results noted in the table are based on two liters of material.

Any fairly rigid container may be used, provided it can be made watertight. It has been found that consistent results are more easily obtained if the top of the container is curved to permit easy removal of all air. In making the original specimen it is important that the clamp be fastened tightly and that the rubber be under some tension to be sure that it corresponds to the shape of the specimens as they change.

The other volume observation (Fig. 2) in all essentials is the reverse determination of the one just described. In this case a bicycle or motorcycle rubber tube section is filled with water and the concrete is placed in a suitable container (4x8 or 6x12 cardboard cylinder mold). The open end of the tube is closed with a large rubber stopper fitted with a glass tube equipped with a reference mark. The tube is filled with water, and the end of the glass tube is closed to prevent evaporation. The volume of this container is determined by water displacement, then placed in a suitable mold and concrete cast around it. The concrete is weighed to give a constant volume with respect to the water bulb on the inside.

When the concrete has reached a suitable structural strength, probably after 24 hours, the water in the glass tube is adjusted to a reference mark for zero. Tests can then be made as desired, varying the curing conditions, storage conditions and temperature.

A convenient testing cycle is seven days of wet curing or storage and seven days of drying. For wet storage the specimens are immersed in water. For dry storage the specimens are placed in an airtight metal drum that is fitted with an air intake and discharge pipe. Air is passed through a drying agent such as concentrated sulfuric acid, then through the drum. Seven days of this procedure thoroughly dries the concrete and is quite comparable with a long dry season.

The samples used for study were obtained in the open market and are cements from six representative Pacific Coast producers. Some of the results of the tests are shown in the accompanying table. It will be noted that the composition is fairly close in all cases but the physical constants vary quite materially. It is to be noted further that the mortar tests with the sand used do not follow the dry-tamped standard sand tests. In the matter of heat of hydration, all the samples were tested with 45 per cent of water. The wide difference in results is rather conclusive evidence that manufacturing detail has as much bearing on the ultimate results as composition. The same answer is indicated in the volume change tests.

In presenting these results no interpretation is offered, but rather the purpose is to show that many possibilities are involved and that investigational work may be done at small cost, with interesting and valuable results. It is suggested further that engineers should have testing procedure available to permit of specifying and verifying the physical properties necessary to their concrete design rather than chemical composition, which is apt to prove disappointing.

It is hoped that further investigations on the part of others may be stimulated by this information with the result that more efficient inexpensive tests may be devised to give a comprehensive picture of the performance of cement in concrete.

Engineering Control Features Illinois CWA Organization

THE ORGANIZATION of the Civil Works Administration in Illinois is typical for those states that have chosen an engineering approach to the problem of putting men to work quickly with the emergency funds provided by the federal government. It is further interesting because of the relative size of its task compared with most other states and the substantial progress that it has to its credit. Some 9,000 projects have been approved. By Dec. 15 the state's quota of 250,000 men was at work, one-half of these men being employed on projects outside of Cook County. The engineering staff on Jan. 10 numbered 1,029 men.

The genesis of the organization began when Prof. W. C. Huntington, of the University of Illinois, was appointed by the governor as head of an advisory board composed of eight engineers. This board named Frank D. Chase chief engineer and provided him with a staff of six engineer assistants. Mr. Chase was recently made director as well as chief engineer. His duties are defined as follows, the first five of which are conducted by the engineering divisions: (1) receiving, examining and approving or rejecting projects; (2) requisitioning workers for Cook County projects; (3) general supervision of all projects; (4) purchasing all materials to be paid for by the CWA; (5) directing all public relations, including labor policies, working conditions and safety programs; (6) directing the auditing, accounting and statistical work.

One assistant chief engineer was assigned to Cook County and a second to the remainder of the state. The state CWA purchasing agent is an engineer with two assistants, one for Cook County and one for the remainder of the state. The Chicago departments of the engineering division are as follows: (1) Cook County inspection; (2) public relations; (3) labor adjustments; (4) compensation insurance; (5) safety; (6) office service; (7) office engineering employment; (8) project surveys.

To conduct the operation of the engineering division outside of Cook County there are eight district engineers and their staffs, each of which has a district purchasing agent.

The projects originate in applications to the CWA by the local tax-supported bodies. If approved, the projects are carried out under the direct supervision of the applicant, which becomes the employing agency. The payrolls are certified by the county certifying officers, and pay checks are made out by the county disbursing officers.

FEDERAL CIVIL WORKS ADMINISTRATION FOR ILLINOIS

State Administration

State Board:
R. J. Dunham, chairman
W. S. Reynolds, exec. sec'y.
Omar H. Wright
George A. Barr
Edw. J. Barrett
John C. Martin
J. J. Rice
Victor A. Olander
John Pierre Roche
Wm. H. Sexton
Charles Boeschenstein
Director and Chief Engineer: F. D. Chase
Engineering Advisory Board:
W. C. Huntington, chairman
D. J. Brumley, vice-chairman
C. B. Burdick
M. Gunderson
A. J. Hammond
C. MacChesney
A. Reichmann
C. C. Whittier
Chief Auditor: R. L. Peters
Chief Statistician: R. J. Myers
Business Manager: F. A. Deniston
State Purchasing Agent: A. M. Crain
Office Engineer: C. H. Lamb
Safety: A. E. Holdstedt
Office Service: R. W. Howard
Compensation Insurance: I. L. Scott
Public Relations: A. C. Johnson
Labor Relations: T. Turnquist
Employment: G. J. Trinkhaus
Information Service: J. Foster

Cook County Administration

Disbursing Office
Re-employment Service
Employing Agencies
Assistant to Director: M. H. Bickham and field representatives.
Assistant Chief Engineer: A. R. Lord
Staff Engineer: P. W. King
Project Surveys
Assistant Purchasing Agent: D. Crumlich and deputy purchasing agents.
Inspection:
H. B. Anderson and project engineers

Outside of Cook County

Disbursing Office
Re-employment Service
Employment Agencies
Assistant Chief Engineer: P. E. Green
Staff Engineers:
W. D. P. Warren and P. B. Wilson
Assistant to Director: S. E. W. Bedford
Office Manager: E. F. Bamford
Field Manager: B. C. Getsinger
Chief Field Representative: H. K. Seltzer and field representatives.
District Engineers:
No. 1: B. P. Thacker
No. 2: H. A. Reidesel
No. 3: H. A. Hunt
No. 4: T. L. Flatt
No. 5: J. E. Weinel
No. 6: W. R. Stoune
No. 7: G. H. Anderson
No. 8: C. H. Petry
Project Engineers
District Purchasing Agents
County Purchasing Agents

Planning and Research Prominent At Civil Engineers' Meeting

National development problems and utility regulation receive principal attention at annual meeting—Detail subjects of discussion include bridge floors, underground corrosion, river model testing and better field engineering

THE EIGHTY-FIRST annual meeting of the American Society of Civil Engineers, held in New York, Jan. 17-20, 1934, was built around seven technical sessions, in which six of the technical divisions took part. Development planning and governmental operation of utilities were outstanding themes of discussion. Committee reports, with a few exceptions, were relatively barren of new material, reflecting the curtailment of funds for such work. Of the technical sessions, that of the city planning division was notable in bringing together several papers on the timely subject of national planning with particular reference to highway, rail and water transportation and conservation of national resources. A paper in the waterways division meeting on field verification of tests made at the Vicksburg hydraulic laboratory and the several papers and reports on bridge floors at the structural division meeting are also worthy of special note.

Among the major general events of the meeting were the election of Harrison P. Eddy, of Boston, to the presidency to succeed Alonzo J. Hammond, and the conferring of honorary membership on Dean F. E. Turneaure, of Wisconsin University. The John Fritz medal, awarded annually by the four Founder Societies, was presented posthumously to John R. Freeman for his varied and substantial achievements. Other medals and prizes were awarded as follows: Norman medal to Prof. Hardy Cross; J. James R. Croes medal to Col. Earl I. Brown; Thomas Fitch Rowland prize to the late John C. Baxter; James Laurie prize to W. B. Saunders; Arthur M. Wellington prize to D. J. Kerr; Collingwood prize for Juniors to Bernard L. Weiner; and the Alfred Noble prize to C. Maxwell Stanley.

At the business meeting, the Board of Direction's recent action in expanding the code of ethics to include a provision prohibiting full-time teachers and municipal employees from practicing engineering for less than standard fees received considerable criticism on the instance of a resolution offered by Prof. John H. Gregory directing the board to reconsider its action. Questions were raised not only as to the advisability of such a provision, which was characterized as class legislation, but as to its legality unless submitted to letter ballot of the membership. The meeting voted to refer the entire subject to the Board of Direction.

Committee reports

Four research committee reports were presented. Prof. Clyde T. Morris (Ohio State University) reported that the committee on concrete and reinforced concrete has completed its large model tests at the University of Illinois, and that the final report is being prepared and will be ready for next year's meeting.

The committee on earths and foundations announced plans for model studies of some of the new locks and dams on the Mississippi River and also stated that experimental work will continue at Yale on sheetpiling and at M.I.T. on soil consolidation. Dr. Terzaghi, now in Vienna, will continue his contributions to the committee work. An unusually novel and interesting addition to the committee's activities will be a new series of tests at Columbia University in which models of tunnels and other earth structures will be loaded by rotation in a centrifuge. The work will be under the direction of Prof. Philip B. Bucky, who has developed the method and used it for designing mine openings.

The committee on irrigation hydraulics, after a long and successful existence, announced its dissolution through D. C. Henny, chairman. The committee on meteorological data reported that it is marking time until the proposed reorganization of the Weather Bureau provides it with a more certain base upon which to build a program.

Four types of national planning

Current problems of exceptional importance were discussed in four papers constituting the program of the City Planning Division. All four dealt with national planning as contrasted with city planning; in fact, one of the papers, that of Major Carey H. Brown, indicated that city plan development has been quite inadequate to the requirements of emergency employment through public construction.

Major Brown, acting chairman of the PWA Technical Board of Review, said: "Considering the country as a whole, planning efforts were too much localized, and too thin unfortunately, to find our cities in general prepared with programs when faced with the necessity of providing work." After indicating some of the causes of this condition, he pointed out that financial planning is quite as important as physical planning in any such undertaking. For example, he said: "A long-term schedule of financing in accordance with prospective income, expense and fixed charges seems an obvious desirability, but is an all-too-infrequent fact . . . There is crying need for better adaptation of legislation and government to the logical development of public works, as every one will testify who has attempted to adapt a sewer system to a topography-scorning city line, or who has encountered multiple layers of government which separately tax, plan and 'improve' many of our communities."

Following this, he discussed briefly the necessity of land planning on a national scale, because disappearance of the frontier has brought the period of land exploitation to an end and calls for comprehensive policies of conservation and land use. The frontier of the city has not yet disappeared, however, and exploitation here seems likely to continue for some time. One solution of the problem of the abandonment of city property and development of new sections in suburban areas is seen by Major Brown in improvement of tax assessment systems, with reduction of assessed values on run-down residential property in the inner regions of the cities. He concluded that: "The development of plans, city, regional, state and national, would seem to afford the most effective means of combating the pork-barrel and log-rolling schemes of allocation of public improvements." And that: "A sequel to the execution of public-works programs, or in fact to the carrying out of any type of spending as a means of hastening recovery, is the necessity for rapid amortization in the period of good times."

Highway planning in relation to the development of the major highway system was discussed by E. W. James, chief, division of design, Bureau of Public Roads. First indicating the abnormal influences now bearing on highway planning, including budget balancing, control of land use, such regional planning as that of the TVA, and combined farm and industry development, Mr. James turned to the rapid growth of federal-aid highway systems (from 33,000 miles in 1922 to 207,000 miles in 1933), and outlined the relatively simple basis of planning in the early days of the system, when population and farm production were adequate guides. Conditions since have become far more complex, and planning today must take account of a greater number of variables and factors. In the Tennessee Valley, for example, new activities and land use will require a greater development of highways than in other parts of the state. For greatest effect and economy the highway system of the future must be planned in close coordination with agriculture, forestry, land use and economic planning.

National transportation

In a paper entitled "How National Planning Can Help in the Development of Coordination of Rail, Highway and Waterway Systems," C. O. Sherrill, Cincinnati, Ohio, reviewed the planless development of our transportation system in the past and voiced a call for undertaking immediate, comprehensive and continuing planning.

Pointing out that the early waterways were developed as a necessary improvement over the poor roads and trails of pioneer days and that later the railroads destroyed water transport "to a considerable extent by the dicriminatory rates given by railroads to competing water points," he charged that recent waterway projects have in many cases been carried out by Congress against engineering recommendations that the projecst were economically unsound. Respecting highways, he remarked that during the development of the modern highway transportation system and the motor car "the railroad executives peacefully slept, tied to their rails, while this giant competitor grew and developed in every direction. . . . It was only when highway transportation had grown in volume to the point of becoming a serious competitor that the railroad executives began to show signs of awakening. Even then they did not set about utilizing this new flexible and highly serviceable means of transportation, but contented themselves with efforts to harass and destroy this competitor by propaganda and extensive lobbying against it in the national and state legislatures."

Continuing from these premises, Colonel Sherrill put forward the thesis that sound planning will prevent destructive competition of transportation services and will work out the proper field for each type. The fundamental principle that the public is entitled to the most efficient means of transportation available in the separate fields is now thoroughly accepted, and on its basis a national plan of transportation development should rest. To this end a permanent commission should be created by Congress to develop and maintain a comprehensive transportation plan for the country, he argued. Its field of study would include regulation, taxation, dimensions and loads of highway vehicles, type and dimensions of main highways, relations between competing railroads, determination of uneconomical railway lines that should be abandoned, principles of waterway development, rates and operating principles of the several transportation services, elimination of unnecessary competing railroad yards and terminal facilities and the like.

Closing the group of four papers, Dr. Arthur E. Morgan, chairman of the Tennessee Valley Authority, discussed the conservation and past use of natural resources. The Tennessee Valley project, he indicated was initiated, in one sense, to furnish a limited area in which various elements of social and economic planning could be worked out before being applied to the country as a whole. Referring to the power part of the TVA program, he said that the Authority has worked with the Commonwealth & Southern and has agreed to purchase some of the latter's plant, about $3,000,000, with a mutual understanding to keep out of the other interested territory. The TVA is concerned with the question of what power ought to cost, how much greater use of electric power can be brought about, especially through the distribution of cheaper domestic equipment, such as electric ranges, and what coordination of power resources is possible. Dr. Morgan pointed out that through joint operation of the power and storage developments along the Tennessee River and its tributaries it is possible to produce five or six times as much prime power at Muscle Shoals as if the plants were operated independently; also that coordination is expected to cut the cost of power in the region at least in two. In reply to a question, Dr. Morgan stated that if public ownership demonstrates itself to be cheaper and more effective, it is bound to replace private ownership of utilities.

Elevated highways

The two papers which, with very brief discussion, made up the program of the highway division, were descriptions, with general considerations of the traffic service, of the elevated highway along the Hudson River waterfront of New York City and of the companion superhighway trunkline from the Holland Tunnel out through the metropolitan area of northern New Jersey. Presenting charts of the Day and Zimmerman survey of sources and destinations of traffic on Manhattan as affected by the various contributing arteries of river bridges and tunnels, Benjamin Schwerin, assistant engineer, department of public works, Manhattan, pointed out the strategic position of the new West Side elevated street. Not only does this elevated highway effectively distribute north and south traffic but it also separates fast and slow traffic by confining the latter to a surface street beneath. The paper on the Holland Tunnel approach road, by W. G. Sloan, state highway engineer, and S. Johannessen, designing engineer, New Jersey State Highway Commission, presented a general summary of the intricate planning problem and gave charts and tables disclosing the generally close agreement of actual traffic development with the growth assumed in the original planning. Discussion of the two papers was limited to questions asking for explanations of minor points of design and traffic.

Bridge floors

The structural division meeting was devoted wholly to the timely subject of bridge floors. Shortridge Hardesty, chairman of the committee on bridge floors, outlined an extensive program that has been mapped for future study. Completion of the work is expected to result in a comprehensive design manual. The first chapter, on general provisions, has been completed by C. A. Melick, member of the committee and formerly highway bridge engineer of Michigan.

A paper by J. P. Growdon, assistant chief hydraulic engineer, Aluminum Company of America, and R. M. Riegel, recently engineer of design of the Pittsburgh public-works department, on the new aluminum floor of the Smithfield St. Bridge at Pittsburgh, covered in general the same data that were presented in two articles published recently in *Engineering News-Record* (Nov. 23, 1933, p. 611, and Dec. 28, 1933, p. 783).

Important correlation of experimental data and results of theoretical analysis on the subject of concentrated loads on concrete slabs was given by Prof. Clyde T. Morris in a report of the committee on masonry and reinforced concrete. Experimental results available date back some twenty years to 1912 and 1913, when tests were made by Slater at Illinois, Morris at Ohio State and Goldbeck at the Bureau of Public Roads. The first and only complete theoretical analysis of the problem was worked out in more recent years by Prof. H. M. Westergaard, of the University of Illinois (*Public Roads*, March, 1930). Professor Morris' report brought out the remarkably close agreement between the analytical and experimental results, and on the basis of this agreement presented a set of design rules involving simplified approximate equations. These rules follow:

1. When loads are not nearer to the lateral edge of a slab than about the span length, the effective width of slab for a single central load may be taken as $E = 0.6s + 2c$, in which s equals the slab span and c equals the diameter of the circular area over which the load is assumed to be applied. It is to be noted that the term "effective width" has come to be recognized as that width (taken on a line through the load parallel to the support) over which a concentrated load may be considered as uniformly distributed to give the same calculated stress in the slab as the maximum stress actually produced by

the load. (For highway truck wheels, it is stated that the diameter c may be taken as 1 in. for each 1,000 lb. of load on the wheel.)

When two loads are a fixed distance apart on an element (such as the front and rear wheels of a truck), their position for maximum moment is the same as for a simple beam. The effective width to be used in connection with the total moment may be increased somewhat over that used for a single load at the center. The report gives the amount of this increase, and it also states that it will always be on the side of safety to use the same effective width as for a single central load.

2. In considering loads on parallel elements, the increase in moment in one element of a slab caused by loads upon another separated from the first one by distance y is given by the equation:

$$\text{Per cent increase} = \frac{100}{1+(y/s)^2}$$

3. When slabs are of less width than about 1.6 times the span length and have unsupported edges, the effective width is $(e/E + 0.78)^2 = 3.2b/s - (b/s)^2 + 0.608$ in which e is the effective width of a slab of width b and E is the effective width of a slab of indefinite width.

4. When loads are applied closer to an unsupported edge of a slab than about 0.8 of the span length, the effective width may be taken as $e = 1/2e_o + d$ in which e_o is the effective width for a central load and d the distance from the load to the nearer edge.

5. When the transverse edge of a slab is supported by a beam, the maximum moment of the beam may be taken as $M = 1/2\ Rs$. The reaction R at the end of the transverse beam is given by equations in the paper.

The report is being published as Bulletin 80 of the Engineering Experiment Station, Ohio State University, Columbus.

Discussions were presented by Morris Goodkind, bridge engineer, New Jersey state highway department; Allston Dana, engineer of design, Port of New York Authority; and Leon Moisseiff, consulting engineer, New York. All praised Professor Morris' report as a contribution that relieves uncertainty on a vital point in slab design, and gave credit to Professor Westergaard for removing a great deal of mystery from a difficult problem. Mr. Goodkind and Mr. Dana approved of Professor Morris' simplified equations for effective width and moments, but Mr. Moisseiff urged the use of Professor Westergaard's exact equations on the ground that there is no excuse for empiricism when exact solution is possible with little added labor. Another point stressed by both Mr. Goodkind and Mr. Dana is the importance of considering the longitudinal bending moment in slabs caused by loads on the transverse beams. Mr. Dana also thought that the compression at right angles caused by such a longitudinal bending moment should be investigated.

The field for light bridge floors, in Mr. Goodkind's opinion, is most apparent in long-span structures and in movable bridges. The New Jersey highway department has used steel grids filled with concrete on bascule spans, with considerable success. High unit stresses in such concrete fill demand that the concrete be of exceptionally high quality.

In ascribing the same strength to the structural aluminum alloy ST27 that is usually given to silicon steel (as was done in Mr. Growdon's paper), it is necessary to use caution, in Mr. Dana's opinion. While the two materials do have about the same yield point, the spread between yield point and ultimate in silicon steel is much larger than for aluminum. Mr. Moisseiff also stressed the necessity for taking ultimate strength as well as yield point into consideration in fixing unit stresses. The future of structural aluminum lies in using it for the carrying structure of bridges more than it does in lightweight floors, in Mr. Moisseiff's opinion, because there are steel floors, such as the open-mesh, the concrete-filled grid and others, which compare favorably with aluminum floors on a weight basis.

Pipe corrosion underground

Variation in the concentration of oxygen in the soil surrounding a metallic pipe was held to be probably the most important factor in determining the rate of subsoil corrosion, by A. H. Logan, of the Bureau of Standards, in a paper entitled "Underground Corrosion." The bureau has found that the character and extent of soil action varies with the soil conditions more closely than with the character of the pipe material. The rate of corrosion decreases materially after a few years of exposure to the soil, first because settling of trench material makes oxygen concentration in the soil more uniform, and second because deposited corroded material on the pipe offers protection.

The conclusion has been reached that differences in oxygen concentration are of more importance than either soil acidity or differences in electrical potentials between adjacent portions of the pipe line.

Among the methods suggested for reducing corrosion losses are the use of copper and copper alloy pipe, which corrode less rapidly than ferrous metals, increasing the thickness of the pipe wall and using protective coatings. Even though protective coatings are relatively short-lived, they protect the line from the corrosive process when the corrosion rate is high.

A development of the fundamental factors involved in the flow of a fluid substance through a foreign material was presented by Prof. Gordon M. Fair (Harvard University) in a paper entitled "On the Flow of Water Through Sand," presented before the sanitary engineering division. Professor Fair's paper, which was a refinement and enlargement of the paper he presented on the same subject last June at the Chicago meeting of the American Water Works Association, applied the basic formula of Poiseuille for streamline flow of a fluid through a capillary tube to the flow of water through a particulate material. To this end several transformations of the factors in Poiseuille's equation were necessary, one of the most important being a transformation of hydraulic radius into the ratio of void volume to aggregate sand-grain surface. After the necessary transformations are made, the result is a mathematical expression for hydraulic slope which can be applied both to ordinary flow and to upward flow, which results in expansion. Experimental data were presented that confirmed the theoretical conclusions.

Field engineers criticized

Field engineers on construction work received considerable criticism in a paper delivered before the construction division by H. S. Crocker, consulting engineer and contractor of Denver and past president of the Society. Colonel Crocker placed the blame for poor engineering service rendered in the field on the lack of practical construction training given engineers in college and on the practice of turning over important field work to inexperienced men. Discussion following presentation of the paper indicated that little practical training was possible in engineering courses and that the field was the place to acquire practical experience.

One of the weaknesses of the field engineering service today is the failure of engineers to realize that field responsibilities are as important as responsibilities for correct design. It is important also to note that incompetent field men must necessarily take plans literally, forcing contractors to uneconomic practices, when some compromise, based on sound field engineering judgment, would often reduce the cost to the owner and produce a better structure. The theory of the superiority of the designer and specification writer has always been grossly in error, and good field engineers, both as representatives of the designer and the contractor, are needed to improve upon the office work when the structure is actually being built.

Improvement of the status of the field man within the profession is highly necessary. At present he is definitely underpaid, and he is not encouraged to assume responsibility.

Improved opportunities

The opportunities confronting construction engineers today, whether they are employed by contractors or designing engineers, are more numerous than ever before, in the opinion of A. P. Greensfelder, chairman of the executive committee of the construction division and president of the Fruin-Colnon Construction Co., St. Louis. Construction engineers should set themselves to study the fundamentals of construction demands, their relation to finance and to the development of the natural resources of our nation. Opportunities exist for employment in the shops, mills or plants producing construction materials and equipment. The marketing of equipment and materials also calls for construction engineers. Another field of promise for construction engineering concerns the safety of workmen. The unduly large number of minor and major accidents on construction projects can be greatly minimized, and the resulting economic loss to the construction industry must be reduced.

The construction engineers must make it a part of their jobs to study the various financial elements and their relation to construction projects. A proper time to vote bonds for construction work, to sell these bonds and to buy construction with the bond funds must be determined by the engineer. The engineer should also consider what public works should be financed through bond issues, what should be paid for from general revenue and what should be assessed as special taxes or paid for by service charges.

One of the ripest opportunities for construction engineers lies in developing a proper economic field for winter work, to aid in leveling out the seasonal construction curve. Bonding and insurance requirements equitable both to the contractor and owner need to be developed. Development of sound cost-accounting methods is needed.

PWA in Missouri

Hugh Miller, state PWA engineer for Missouri, told the construction division of the work being done in that state. Projects totaling $99,000,000 have been approved, but very few contracts have actually been let. A change in attitude on the part of the public regarding bond issues for public works has been noted in Missouri. Last fall numerous bond issues were turned down by the voters. Lately, however, upon second presentation of the bond issues, the voters have approved them. Mr. Miller attributes this to the realization by the public that under the present system of federal taxation every part of the country is helping to pay for public works, and therefore each community might as well get its share.

Government ownership

Frederick H. McDonald's paper on the equitable theory of governmental ownership and operation was the single subject for consideration at the general meeting arranged by the engineering-economics and finance division.

Discussing the immediately urgent demand for reducing cost of government, Mr. McDonald cited the two principal means as reducing "the volume of unreasonable personnel and expense of even the necessary activities of government" and "elimination of the unjustifiable and un-legal activities or cost of government." The latter, because of its more direct interest to the engineer, was taken as the subject of his paper. Working from the premise that where governmental agencies are engaged in the operation of revenue-producing services the minimum selling basis mandatorily should be sufficient to pay all costs, including taxes, he set about to outline a system of integrated public and private power production and distribution that would, in his opinion, prevent the wasteful destruction of our existing private electric utilities and at the same time would permit the development of a publicly owned power-production system. Mr. McDonald holds that the general public should not be taxed to subsidize any service that is not of direct benefit to all who bear the tax; he holds further that such subsidy can be avoided through a "judicially mandatory" self-supporting rate structure for publicly operated services.

Turning from theory to fact, Mr. McDonald cited the danger of the federal policy that has taken concrete form in the Tennessee Valley Authority, and, assuming that the nation already has gone too far along the road toward public ownership of power to turn back, he sets forth a proposal for continuing that policy in a somewhat modified form without destroying the value of existing electric utility systems. Using the existing or proposed government plants in the Tennessee Valley, Boulder Dam and on the Columbia and St. Lawrence Rivers as a great interconnected source of primary power, he would sell power to the private utilities at such rates as to permit them to resell it at rates considerably below existing rates in order to stimulate a great expansion of the use of electric energy. Existing plants would be used for stand-by purposes. While in the development period, the federal government would carry the actual losses of the private utility companies. As an aid to developing the much greater demand for power, Mr. McDonald would eliminate all uneconomic duplication in railroads, thus producing a density of combined traffic that "will make electrification of every mile of railroad in the United States imperative for more economy's sake."

The legal aspects of Mr. McDonald's proposal were discussed by Prof. James P. Gifford, Columbia Law School. He concludes that self-supporting rates cannot be made mandatory, that there is nothing illegal in a partial subsidy, or in fact in an entire subsidy, of a service rendered. As an example, he cited the post office department.

In a second written discussion, Gen. Chas. Keller cited the Inland Waterways Corp. as a good example of the difficulty of accurate determination of costs of government operation.

Discussion from the floor was active. In reply to a defense by A. J. Bernstein of the federal government's present power policy in which he indicated that there was contained therein no threat to existing utilities, W. S. Lee quoted from Secretary Ickes' reply to American Engineering Council on the subject of government competition in which he would not commit the federal government but stated that the matter of policy in that regard would be left to the local community to decide. A. W. Consoer, Chicago, referring to the engineer's connection with public development of power, stated that frequently engineers were guilty of intellectual dishonesty in the reports they prepared for cities going into the electric utility business.

Waterways

Progress to date in the field verification of river hydraulic laboratory results was the subject of an illustrated paper before the waterways division by Lieut. H. D. Vogel, of the U. S. Waterways Experiment Station, Vicksburg, Miss. Very encouraging results obtained in the many model studies and put into practice on the river have fully justified the cost of the work carried forward by the Mississippi River Commission. Another two or three years, Mr. Vogel said, will be required before the laboratory staff will have definite information as to the reliability of the several types of models employed. Especially encouraging are the results obtained in movable-bed models in which, by beginning the test with a set of conditions as they are known to have existed in the past, it has been found possible to obtain present conditions by running through the intervening cyclical-flow conditions.

Details of some of the river laboratory problems were discussed by Prof. K. C. Reynolds, of M.I.T., and H. N. Eaton, of the Bureau of Standards; Emil P. Schuleen of the U. S. Engineer Office at Pittsburgh, discussed the verification of some of the results of tests conducted by that office. Mr. Eaton directed his discussion chiefly to movable bed material and stated that two important problems before the river laboratory workers are the determination of the range of application of commercially available sands for bed material, and the development of artificial sands to meet conditions not met by commercial sands.

Gerard H. Matthes, Vicksburg, in a written discussion, laid emphasis on the fact that the Vicksburg laboratories, in order to justify their construction and continued existence, have to devote attention to practical rather than theoretical questions. The magnitude of the problems yet unsolved and the economies already made, he said, indicated that the existing laboratory should be expanded and that adequate funds and staff should be provided.

"Littoral Drift," a paper by J. J. Hennebique, was the second subject considered by the meeting of the waterways division.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Winter Conditions on Mount Washington

Reviewed by M. N. Baker
Upper Montclair, N. J.

MOUNT WASHINGTON REOCCUPIED—The Experience of a Scientific Expedition Upon the Highest Mountain in New England—1932-33—By Robert S. Monahan. Cloth; 6x9 in.; pp. 270; 2 maps and 48 halftone views. Published by Stephen Daye Press, Brattleboro, Vt. $2.50.

SIXTY-ONE years after the first winter-long occupancy of Mount Washington another party of volunteer scientific observers withstood the snows, terrific winds and sub-zero temperatures of the highest point in New England. How the later party was organized, equipped, housed and fed, kept in contact with the outside world and did its work, as well as the high spots in its scientific observations, are told in Robert S. Monahan's "purely personal journal," entitled "Mount Washington Reoccupied."

After the pioneer voluntary occupation of 1870-71, to which an observer was delegated by the U. S. Signal Service, predecessor of the Weather Bureau, the Mount Washington Station was maintained by the federal government from 1871 to 1887, the year round and as a summer station five years more.

In the reoccupation of last winter, improved scientific equipment and more of it was available, including a heated anemometer and radio apparatus. Much attention was given to radiology, for its own sake and for the benefit of aerial navigation.

Like the occupation of 1870-71, that of last winter was financed privately and the staff served without pay. For last winter and the hoped-for occupation of a second winter the "strictly meteorological expenses and supervision" were undertaken by the Blue Hill Meteorological Observatory of Harvard University and the Meteorological Course of the Massachusetts Institute of Technology.

Mr. Monahan's book may well renew attention to the need for permanent Weather Bureau stations at high altitudes, particularly on isolated peaks free from neighboring interference.

The story of the 1870-71 occupation was ably told in "Mount Washington in Winter" (Boston, 1871). The older book also contains a vivid journal by one of the observers, written under living and working conditions that were primitive compared with those portrayed in Mr. Monahan's journal. The older book contains a tabulation of daily meteorological observations, while the later one gives only textual statements of more significant data. If the later data were too voluminous for inclusion in full, selected data parallel to that in the 1870-71 record might have been feasible and would have been valuable.

Defense Against Termites

TERMITES AND TERMITE CONTROL: A Report of the Termite Investigations Committee—By Charles A. Kofoid, S. F. Light, A. C. Horner, Merle Randall, W. B. Herms, Earl E. Bowe. Cloth; 6x9 in.; pp. 734; photographs, tables and line drawings. Published by University of California Press, Berkeley, California. $5.00.

INFORMATION on termites and upon means of protecting wooden structures against their destructive attacks heretofore has been scattered and incomplete. Here it is all assembled under one cover in a manner that should prove satisfactory alike to the architect, engineer or biologist.

The book is divided into four major parts: termites and their biology, chemical investigations, termite resistivity of wood and building material, and prevention and repair of termite damage. To the engineer, architect and builder the second and fourth parts are of chief interest, but it should be said that the first part will be found of value in determining the particular types that may be found in any section of the country and in classifying the types found.

The characteristics and geographical distribution of the many types of termites are given. Part I also contains a chapter on wood-boring insects whose appearance or workings resemble that of termites.

The section on chemical treatment covers both the subject of treating wood to make it immune to termite attack and methods of eradicating termites by poisoning. Many wood preservatives and commercial protective compounds are described and their effectiveness or limitations are stated.

The chapters on prevention and repair of damage take up about one-third of the book and go into considerable detail as to inspection to discover termite attack and methods of construction to be employed in making buildings immune to them. A large amount of space is devoted to telephone and power-line poles, one of the chief sufferers in termite-infested regions.

The Termite Investigations Committee was organized in California following the publication of the final report of the San Francisco Bay Marine Piling Committee in 1927 (*ENR*, Feb. 16, 1928, p. 290).

Stainless Steel

THE BOOK OF STAINLESS STEELS—Edited by Ernest E. Thum. Cloth; 6x9 in.; pp. 631; photographs, line drawings and tables. Published by American Society for Steel Treating, Cleveland, Ohio. $5.

The commercial success of the heat and corrosion-resisting alloys of steel, collectively known as chromium alloys and generally referred to as stainless steels, is a development of very recent origin. In many fields the potentialities of these metals have just begun to be appreciated, and the civil engineering field is one of these. This book is a product of the collaboration of some 75 authorities, each a specialist in some phase of the subject. It is arranged in four parts—production and fabrication; properties of typical alloys; requirements of the consuming industries; and a tabular classification, on the basis of alloying elements and carbon content, of all trade names of stainless steels. Roughly, about two-thirds of the book is devoted to properties of the steels—that is, how to fabricate them and what to expect of them. Most of the remainder of the book is devoted to describing successful applications of stainless steels to specific uses. The contents of the book are sufficiently precise to be of practical value to the metallurgist, but the principal value of it will accrue to prospective users and others who have not had the time nor opportunity to keep abreast of the most modern metallurgical developments.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

THE ECONOMICS OF THE RECOVERY PROGRAM—By D. V. Brown, E. Chamberlin, S. E. Harris, W. W. Leontief, E. S. Mason, J. A. Schumpeter and O. H. Taylor. Cloth; 5x8 in.; pp. 188. Published by Whittlesey House, McGraw-Hill Book Co., New York and London. $1.50.

INLAND TRANSPORTATION—By Sidney L. Miller. Cloth; 6x9 in.; pp. 822; tables and diagrams. Published by McGraw-Hill Book Co., New York and London. $4.00.

POWER SUPPLY ECONOMICS—By Joel D. Justin and William G. Mervine. Cloth; 6x9 in.; pp. 276; diagrams and tables. Published by John Wiley & Sons, Inc., New York. $3.50.

ENGINEERING NEWS-RECORD

Vol. 112, No. 4.

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d Street, New York

January 25, 1934

Reviving Activity

IF THE SPIRIT of fresh initiative that enlivened the meeting of the American Society of Civil Engineers last week can be taken as an indicator, the profession is heading toward better times. Optimism and enterprise spoke out of the attitude of the participating members as well as out of the technical proceedings of the meeting—the latter marked by originality of theme and viewpoint, especially in the discussion of planning and utility problems and in the study of projects of committees. Coming after a year of hard experience for everyone connected with civil engineering, the strengthened spirit is perhaps in part a resultant of the public-works recovery campaign. But it also gives evidence of an abiding faith in the vitality of technical service. It suggests that events have caused the need for professional cooperation in the advancement of the economic as well as the technical phases of engineering work to be recognized with new clearness. And this is a particularly welcome development, for through such cooperation a stronger society and a stronger profession will be built.

Honor to a Leader

THE HIGH HONOR of the John Fritz medal award acquires added distinction through its bestowal on the late John R. Freeman. His own pioneer contributions to engineering are in themselves full warrant for ranking him among the greatest engineers of his generation. He furthered human progress not only through his own genius and effort but through a broad philanthropy. Its impulse led him to collect and publish much important knowledge (most recently his earthquake-damage data), or to found a new educational agency in his European traveling fellowships, or again to give freely toward the establishment of a model hydraulic laboratory in the national service. But he left his impress on the engineering world also in another way: he selected as his collaborators young men of exceptional quality, and by his inspiration and direction developed them into leaders of the profession. This was not the least of his services to his fellowmen, and in the achievements and the legacies of his disciples it bids fair to find an enduring memorial.

Effective Work

CLOSING ITS ACTIVITIES after twelve years of continuous effort, the research committee on irrigation hydraulics leaves a notable record of addition to knowledge, and this under the special condition that the committee acted only as coordinating and stimulating agency and did no research work itself. Perhaps because of this very fact it succeeded in bringing about important progress in numerous problems, including evaporation, dam uplift and scour, canal flow, gaging devices and spillways. Its method of procedure was to single out a subject where adequate knowledge was lacking, outline the major elements of inquiry, and encourage research by men who were practically concerned with the matter involved. The results obtained prove the value of the method where conditions suit. In irrigation hydraulics there exist so many operating and engineering organizations that opportunities for experimentation by both government and private agencies are unusually ample and there is direct stimulus to research in the dollar value of more precise knowledge—for example, on water-delivery measurement. While the coordination method of directing research is neither new nor rare, it has not often been applied in so thorough a manner as by the committee which D. C. Henny and J. C. Stevens headed. Its accomplishments set a model that should inspire increased activity in civil engineering investigation.

Transportation Improvement

THE ARGUMENT for a coordinated attack on the transportation problem, previously urged by the National Transportation Board (*ENR*, Feb. 23, 1933, p. 262), was strongly restated by C. O. Sherrill in a paper which he presented before the Civil Engineers. He expressed the interdependence of road, rail, water and air transport in clear language, and in few but pointed words pilloried the antagonisms and political motives that place the waterway in unfair opposition to rail transportation and the railway in unfair opposition to road transportation. From this premise he proceeded to the recommendation that a commission be established to outline sound policies of transportation development and administration on the basis of the recognized principle that the public is entitled to the most economical and efficient method of transportation available for each particular movement. No such policy-forming body exists today or has existed in the past. Clashes and misadjustments are by no means decreasing, and since the principle of maximum transportation utility is at present only an academic truth, without tangible recognition other than that supplied through unrestrained competition, the reasons in favor of Colonel Sherrill's proposal appear compellingly strong. The present is a particularly favorable time for practical application of the principle.

Railroad Report Disappointing

THE FIRST REPORT of J. B. Eastman, railroad coordinator, is disappointing due to its lack of specific recommendation of ways in which railroad conditions can be improved. In particular the problem of the heavy burden of fixed charges is not approached. In one respect it should be said in Mr. Eastman's defense that Congress largely forced him into the position of being unable to submit suggestions for immediate improvement by the labor restrictions that it wrote into the Emergency Railroad Transportation Act of 1933. No proposals were to be put forward that would reduce the number of railroad employees, and, obviously, some of the simplest economies and those most quickly made involve staff reductions through the consolidation of duplicate facilities. Eastman, while he favors ultimate government ownership of the railroads, does not advocate it as an immediate step; nor does he favor forced consolidation upon a large scale as an alternative. But he thinks that one or the other of these expedients will have to be applied unless the present managements can get themselves out of their immediate difficulties fairly soon. Elimination of the labor-reduction limitation of the act, as recommended by Mr. Eastman, is highly desirable. His only other positive recommendation for legislation, that of facilitating consolidation through the creation of federal corporations in which railroads can be merged through exchange of securities, has merit if it will provide an alternative to the super-bureaucratic form of government ownership of the railroads favored by Mr. Eastman as an ultimate objective.

Field Engineering

THE ACTIVITIES of the engineer who designs and the constructor who builds necessarily come together in the production of any structure. Bridging the gap between these two is the work of the construction engineer, without whom effective coordination of designer and builder cannot be assured. Prevailing practice places the young, inexperienced engineer in this responsible position, and relies upon him to bring about due interpretation of the designer's intent as well as maintenance of proper construction standards. Such practice, though customary, is obviously faulty. It is responsible for much of the friction between engineers and contractors who should be working in harmony to the best interests of their common client, the owner. The skill, experience, ability and sound judgment essential to good field engineering warrants the best of attention from the profession. Field engineering often suffers also from a general lack of practical sense, and this lack may deserve attention even in the training of the student. But first of all must come a change of traditional practice in respect to field engineering. Through it the engineering profession can succeed in rendering greater service to construction than it now gives.

A New Construction System

INTRODUCING a new word into the constructor's dictionary, pumped concrete also introduces something new into construction processes. The mere pumping of a mixture of water and earthy solids is of course not new, since hydraulic dredging makes it familiar. But the latter process is not hampered by the requirement of low water content as well as uniformity and homogeneity of mixture, as is the case with concrete pumping. Because of these restrictions, which are severe enough to make one marvel at the accomplishment, the Mississippi River lock-building operation described in this issue deserves to be ranked as a demonstration of creative originality in the handling and distribution of concrete. In addition to its success as a mechanical process, the pumping is noteworthy because it constitutes not merely a means of moving concrete but the heart of a new construction system. The system grows out of the fact that all parts of the work have to be planned for pump distribution: pumps must be located to give the shortest average delivery to the forms, the sequence of placement operations must be so laid out that pipe-line changes will be held to a minimum, and the possibility of coupling up pumps in series and introducing booster units must be definitely provided for—in short, a mechanized system must be worked out that goes far beyond the mere installation of pumps and length of discharge-line pipe. The problem is as nice a one as the art of construction-plant engineering could ask for. That it can be solved effectively is shown by the Mississippi lock-building operations.

Larger Opportunity

ASSURED of increased strength of support on the part of its sponsor societies and encouraged by more vital appreciation on the part of engineers of their public responsibilities, the American Engineering Council enters a period of larger opportunity. This event occurs at a fitting time, for national problems that rest on engineering considerations were never so numerous and pressing as today, and the profession's participation in their solution was never more important.

Thirteen years have passed since the Council began its work. They were years of development, of policy-making and trying out courses of action. High ability was devoted to the task, but there were obstacles. Engineers of many different kinds are concerned with public problems, and the Council, which is the profession's appointed agency for expressing its common views on public matters and making them effective, did not find it easy to determine the joint thought and attitude of all the groups. The fifty to sixty thousand engineers whom the Council represents unquestionably have common thought and attitude on certain public matters; on others they should and might have common thought, could it be developed by adequate discussion of fact. But to find this joint opinion is usually difficult.

At the root of the difficulty is the fact that the profession is highly complex. Its diverse interests are often neutral toward each other and sometimes hostile. Nor has the profession as a whole always interested itself in the community's broad problems of engineering character, or recognized its obligation to share in their solution. Whether for this or other reason, many engineers have known little and cared less about the Council's doings. In homely words the Council had not sold itself to its constituents. Even the governing bodies of some of its sponsor societies remained cold to its activities.

Progressively, however, the profession has come to understand that many public movements involve not only political or business issues but have a profound engineering imprint. Through this understanding it has gradually realized that the seemingly narrow professional responsibility is in truth a very serious public responsibility. And though recognition of the responsibility remained largely dormant throughout the first dozen years of the Council's existence, it has been awakened to strong consciousness by the events of recent months. The Council's function is now seen in clearer light.

Such matters as the planning and conduct of public-works programs, the self-regulation of industry, the reorientation of power policies, study of land use to protect national resources, regional economic development, efficient transportation and distribution—all of them of dominant importance today—have such obvious engineering implications that their relation to professional thinking can no longer be misconceived. They have emerged from the obscurity in which intense preoccupation with industrial activity placed them. And therefore engineering cooperation in public affairs on the basis of joint thought and action becomes vital.

To realize the problem and opportunity presented by these new conditions is in part the obligation of the Council, but in larger part that of the societies that it represents. The work to be done is their work; the directing voice must be their voice. And the work will be done well or ill in proportion as the societies and the members of the profession throughout the country give it their whole-hearted support and guidance.

CURRENT NEWS

CWA Reductions Keep Expenditures Within Budget

Washington Correspondence

REDUCTION of the CWA work-week to 24 hours was ordered by Harry L. Hopkins Jan. 18 to keep CWA within its budget and cannot be construed as official recognition of the construction industry's contention that the wage rates are too high. The PWA scale will remain in effect on all CWA projects and the 30-hour week will be restored as soon as Congress appropriates more funds. After Feb. 17, however, Mr. Hopkins plans to drop 1,000,000 men from the payroll every 2 weeks until demobilization is completed April 15 or thereabouts. When this will actually come to pass will depend, according to Mr Hopkins, on the economic situation. What this may be, he said, is a matter of opinion. It is his belief that public works and industrial activity will pick up rapidly in the Spring but it is more likely that Congress ignoring the trend, will provide for continuing CWA indefinitely. The CWA program is in strong favor at the Capitol and numerous measures have been introduced to perpetuate it.

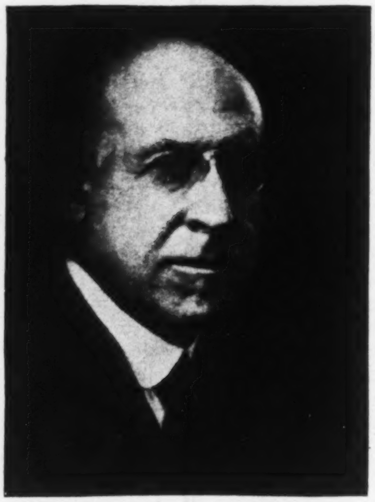
Reductions protested

The temporary reduction in hours, with a corresponding reduction in pay envelopes, brought down a flood of protests upon CWA headquarters in Washington. Administrator Hopkins explained that the cut from 30 to 24 hours in cities and to 15 hours in rural districts was forced by a more rapid disbursement of the available $500,000,000 fund than had been estimated originally. Twelve dollars estimated as the average weekly pay envelope when the CWA program was projected climbed gradually to $14.37, with the result that CWA has been running behind $8,000,000 to $9,000,000 a week.

The retrenchment program includes a closer check on expenditures for materials. State administrators were instructed Jan. 17 to buy no more materials and to make no more commitments without specific approval in Washington. The order was not intended to ban the use of funds for the purchase of materials but in order to distribute funds equitably all field offices were instructed to notify headquarters of estimated material requirements to Feb. 15 and the amount of present unpaid orders.

Available funds

The $500,000,000 fund on which CWA is operating was covered out of a $400,000,000 allotment from public works funds and $100,000,000 from direct relief funds. The total weekly cost has amounted to approximately $75,000,000 of which $60,000,000 is put up by CWA and the remainder by state and political subdivisions. As tentatively ear-marked by President Roosevelt, the additional "recovery funds" of $1,166,000,000 which Congress has been requested to appropriate includes $350,000,000 for CWA.



**Harrison P. Eddy
Elected President of American
Society of Civil Engineers**

The reduction in hours since Jan. 18 applies to all per diem workers on all federal, state and local projects paid out of CWA funds. The maximum for skilled and unskilled labor in cities over 2,500 is 24 hours per week in cities under 2,500 and open country, the maximum is 15 hours per week. For all clerical, supervisory and professional workers, the maximum has been reduced from 39 to 30 hours per week. This does not include administrative workers in administrators' offices.

Graft to be fought

Both Harry L. Hopkins, Civil Works Administrator, and Harold L. Ickes, Public Works Administrator, lashed out at graft this week. Investigation reveals only few flagrant cases in CWA but all complaints are investigated. Mr. Hopkins doubts whether graft run into a great deal in dollars, but he is determined to suppress this even though he cannot prevail against the politics which honeycomb the local CWA organizations. A shake-up is coming in the CWA field organization.

Secretary Ickes declared that workmen on non-federal projects will be protected against any kick-back racket. Workmen may complain to the inspector assigned to each project and restitution will be required if the charges are substantiated. Men will be paid weekly, with no deductions for anything, and wage rate schedules will be posted on pay sheds. The PWA either will buy city bonds in installments or will deposit the entire sum in escrow account in a local bank from which no payments will be made except by permission of the PWA. Local politicians also will be prevented selling jobs on work being done by day labor.

Construction Code Studied by President and Labor Leaders

PRESIDENT ROOSEVELT, Administrator Johnson and a group of officials of the building trades department of the American Federation of Labor conferred at the White House for more than an hour on Jan. 16 in an effort to adjust complaints filed by the Federation against the terms of the master code for the construction industry. Following the conference General Johnson reported that progress had been made and that no fundamental changes would be made in the code. Such changes as are desired would be made through the supplemental code. He said that the basic code provides that schedules of wages for several classes of labor may be written into the supplemental code if the rates are agreed to by both employers and employees. He pointed out that the National Recovery Administration cannot, under the statute, impose a schedule of hours and wages on any industry, that all it can do is to impose minimum wages and maximum hours, that if it could impose a complete schedule the whole theory of collective bargaining would be discarded.

M. J. McDonough, head of the building trades department of the American Federation of Labor, indicated that the differences between labor and the code drafters probably would be settled. He said that the labor group protested the long hours of the construction code and the low rate of wages. They asked that labor be represented on the code authority. Mr. McDonough said that they had requested a 30-hour week on all construction instead of the now prevalent 40 and 48-hour week.

Public Works Program Approved At Conference Held in Ottawa

Launching of an elaborate public works program in the early spring, with continuation of the system of direct relief until such time as the unemployed throughout Canada have been substantially absorbed in industry, was the final agreement of the recent Dominion-Provincial Conference held in Ottawa recently. The understanding is that the funds the federal government has been contributing towards direct relief will be spent entirely on public works, leaving the provinces and municipalities to handle exclusively whatever direct relief might still be required.

Federal circles discussed the probability of the Dominion seeking at the coming session of Parliament authority for an increase of $100,000,000 in Canada's paper money circulation. That this currency, made available by a reduction in the dollar's gold backing, might be used for public works, particularly Canada's share of the St. Lawrence seaway construction, was freely predicted in conference corridors.

Golden Gate Bridge Tower Tests Demonstrated at Princeton

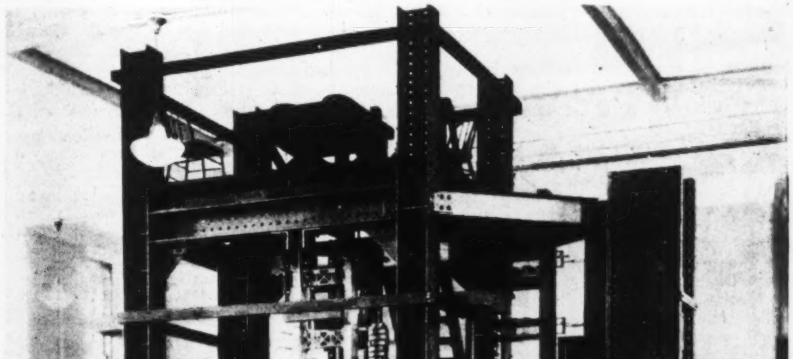
A group of 200 engineers was entertained on Saturday, Jan. 20, at Princeton University, by a program centering on the model of the Golden Gate Bridge towers, which has undergone tests in the university's laboratories. The methods employed in building and testing the model were described by Prof. George E. Beggs. O. H. Ammann, chief engineer, The Port of New York Authority, discussed the place of model testing in present day practice, and Leon S. Moisseiff, consulting engineer, New York, told of the evolution of the design and theory of the Golden Gate Bridge towers. Both Mr. Ammann and Mr. Moisseiff are members of the Golden Gate consulting board and Professor Beggs' work was done for the Bridge District as a check on the analytical design. Prof. F. H. Constant, chairman of the civil engineering department at Princeton, presided at the meeting.

The model, 12½ ft. high, built on a linear scale reduction of 56 to 1, is of stainless steel fabricated into a replica of the cellular tower by means of the special resistance-welding process developed by the Edward G. Budd Mfg. Co. and known as "shot welding." The thickness of the main plates in the vertical shaft of the tower model is 0.017 in. (1/56 of the thickness of the 1-in. plates in the actual tower). Load reductions on the tower model were taken as the square of the linear scale reduction so that the 38,000 lb. vertical load applied to the tower model corresponds to the 120,000,000 lb. vertical load that will be brought to the actual tower by the cables. This simple similitude relationship was possible because the coefficient of elasticity of the steel in the model is practically the same as that of the steel in the actual tower.

Mr. Ammann reviewed some of the developments in model utilization, recalling the use of a celluloid model for the George Washington Bridge tower and of a brass model of the Bayonne arch, the latter built to study sway bracing effects. The stainless steel tower model of the Golden Gate bridge he characterized as a great step forward inasmuch as it uses a material with elastic properties similar to actual bridge steel. In reviewing the evolution of the tower design, Mr. Moisseiff pointed out how the stiff frame, without diagonals, was adopted for the sake of appearance and how this complicated the analytical design. Somewhat similar to the problem of a steel building frame, this one is, however, more complicated, as both transverse and longitudinal movements are possible. An ingenious method of analysis combining the slope deflection method with the use of Williot diagrams was worked out by C. A. Ellis of the office of Joseph B. Strauss, chief engineer of the Golden Gate Bridge and Highway District. In solving the tower as a unit instead of an assemblage of connected parts, it was necessary to utilize some 30 simultaneous equations, and the use of Williot strain equations combined with the moment equations provided this unusual number. The soundness of the theory was demonstrated by computing the stresses in the model according to the theory and then checking the results by testing the model. The computations were made by Frederick Lienhard of Mr. Moisseiff's office.

The testing machine for loading the model was built especially for the tests. The model, mounted on an unyielding base, is loaded vertically by hydraulic jacks and transversely and longitudinally by dead weight. Longitudinal loads consist of the unbalanced cable pull and the reactions of the stiffening trusses. Transverse loads arise from wind (on the tower itself and coming to the tower through the stiffening trusses and the cables) and from earthquake movements. Analytical computation showed a 13-in. side deflection and a 22-in. maximum longitudinal deflection, which were checked very closely by the model. Torsion was also measured. Measurements of strains were made with Huggenberger tensometers, deflection and tower shortening with Ames dials, and torsional rotations with Marten mirrors.

In the accompanying view the model is shown under test. The hydraulic jack on the floor applies the vertical load to the top of the tower model through long rods (on the centerline of the tower) connecting to a cross member on each end of which are chains that pull downward on longitudinal beams corresponding to the cable saddles. Transverse loads are applied through wires at each panel point extending out to the right of the model. These wires pass over pulleys and attach to dead weights which when not in use rest on shelves connected to the vertical member with the adjusting wheel near its base. Other dead weights apply a longitudinal pull to the top of the tower and a moment (in the same direction as the top pull) at the stiffening truss connection.



STAINLESS-STEEL MODEL OF 700-FT. GOLDEN GATE BRIDGE TOWER IN TESTING RIG AT PRINCETON UNIVERSITY

Uniform Traffic Laws Committee Finds Few Revisions Necessary

Following a two-day conference held in Washington, Jan. 17-18, the committee on uniform traffic laws and ordinances of the National Conference on Street and Highway Safety has concluded that the present code needs to be revised in only a few particulars in the light of experience of recent years in the 34 states which have to date adopted the code in whole or in part.

The National Conference on Street and Highway Safety prepared the uniform vehicle code in 1926.

The Committee's re-study of the code and ordinances is being made in preparation for the fourth national conference on street and highway safety to be held in Washington later in the year.

PWA Allotments of $36,000,000 Have Been Withdrawn

ALLOTMENTS for 29 non-federal projects totaling $11,579,000 were rescinded by the Public Works Administration on Jan. 22. Allotments and grants previously rescinded amounted to $20,945,761 and reductions amount to $15,010,000. Thus the PWA has made available $47,535,000 for re-allotment.

State and municipal work

Allotments of $10,880,000 for non-federal projects were approved by the PWA during the past week. Details are given in the accompanying table. Included therein is $4,198,000 to Forth Worth, Texas, for the construction and extension of school buildings and $987,000 to Wheeling, W. Va., for extensions of its sewer system and treatment plant.

The Bureau of Reclamation has been allotted $25,000 for an industrial survey of the Boulder Dam area to determine to what extent the power generated at the dam may be made a factor in the development of the area.

Improvements on the old Post Office at Washington, D. C. to make it available for other government departments is provided for in an allotment of $90,840.

A division of economics and statistics has been set up within the PWA to coordinate its statistical work with that of other federal departments.

A contract covering a loan of $5,060,000 to the Hillside Housing Corp., Bronx, New York, has been approved by the PWA.

Dean F. E. Turneaure Honored by Am. Soc. of Civil Engineers

Honorary membership in the American Society of Civil Engineers was conferred upon Frederick E. Turneaure, dean of the College of Mechanics and Engineering, University of Wisconsin, at the annual meeting of the society in New York, Jan. 17. Dean Turneaure was elected to honorary membership at the summer meeting of the board of direction.

Frederick E. Turneaure

F. E. Turneaure was born on a farm near Freeport, Ill. in 1866 and graduated from Cornell as a civil engineer in 1899. Like most young engineers of the time, he went first into railway engineering work but in 1890 he turned to teaching, becoming an instructor in civil engineering at Washington University in St. Louis. Two years later he went to the University Wisconsin as professor of bridge and sanitary engineering. In 1902 he was appointed acting dean, and in 1904, dean the College of Mechanics and Engineering. The latter position he has held continuously since that date.

In addition to his teaching, Dean Turneaure has found time for other activities of engineering interest. From 1900 to 1902 he served as city engineer of Madison and from 1911 to 1929 as a member of the highway commission of Wisconsin. He has written extensively, his works including collaboration in the well-known three-volume work "Theory and Practice of Modern Framed Structures," also "Public Water Supplies" and "Principles of Reinforced Concrete."

Dean Turneaure has been a member of the American Society of Civil Engineers since 1897.

Real Property Inventory Employs 10,000 Men and Women

Schedules have been completed and more than 10,000 men and women have been put to work on the real property inventory recently undertaken by the Bureau of Foreign and Domestic Commerce as a means of providing employment, according to Willard L. Thorp, director of the bureau. The survey, financed by the Civil Works Administration, will cover a selected list of 63 cities. The field work is to be completed by Feb. 15.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

LIST NO. 44

Locality	Loan and Grant or Grant	Type	Amount
Warrenton, Ga. (Decrease)	G	Waterworks	$4,200
Fargo, N. D.	L. & G	Sewers	134,000
Traverse City, Mich	L. & G	Harbor	303,000
Youngstown, Ohio	L. & G	Dam Repairs	106,000
Burlington, Wis. (Increase)	G	Reservoir	700
Youngstown, Ohio	L. & G	Storm Sewers	175,000
Klamath Falls, Ore	L. & G	Armory	71,000
Vinton, Iowa	G	School	29,700
Springboro, Pa.	L. & G	Waterworks	21,000
Arcadia, Neb.	L. & G	School	74,518
Teachers College, Farmville, Va.	L. & G	Swimming Pool	40,000
Burlington, Kan. (Increase)	L. & G	Power Plant	27,000
Auburn, Ky.	L. & G	Waterworks	48,000
Iowa Falls, Iowa	L. & G	Sewer	49,000
Yankton, S. D.	L. & G	Pavement	10,000
Russell, Ky.	L. & G	Storm Sewer	8,000
Doniphan, Mo.	L. & G	Waterworks	18,000
Cleghorn, Iowa	L. & G	Waterworks	16,000
Dequincy, La.	L. & G	Street Work	6,000
Sparks, Nev.	L. & G	Storm Sewer	45,000
Fort Worth, Tex	L. & G	Schools	4,198,300
Bastrop, Tex.	L. & G	Sewer System	51,000
Harmony, Minn.	L. & G	Water Mains	2,000
Midlothian, Tex.	L. & G	Waterworks	26,000
El Paso, Tex.	L. & G	Sewer System	440,000
Columbus, Ohio	L. & G	Incinerators	292,000
Cass County, Tex	L. & G	Courthouse Repair	38,000
Madison, S. D.	L. & G	Water System	25,000
Bryan Co., Ohio	L. & G	School	5,000
Eureka, Mo.	L. & G	School	68,000
Wheeling, W. Va	L. & G	Sewer System	987,000
New Bedford, Mass	L. & G	Storm Sewer	21,000
Buena Vista, Va	L. & G	City Buildings	10,000
Houston, Mo.	L. & G	Waterworks	57,000
Del Rio, Tex	G	Warehouse	4,000
Bloomfield, Iowa	G	Waterworks	5,000
Webster County, Mo	L. & G	School	31,000
Lawrence, Kan.	G	Waterworks	2,000
St. Francis, Kan	L. & G	School	70,000
Guthrie, Okla.	L. & G	Waterworks	150,000
Vermillion, S. D	L. & G	Waterworks	34,000
State of Connecticut	G	Highway	50,400
Pukwana, S. D.	L. & G	Sewer	16,000
State of Texas	G	Office Building	4,000
Waco, Mo.	G	School	5,000
Lexington, Ky.	L. & G	Public Buildings	203,000
Jackson County, Okla	G	School Buses	500
Jackson County, Okla	G	School Buses	500
State of Connecticut	G	Street	29,000
Beckham County, Okla	G	School Buses	500
Jackson County, Okla	G	School Buses	500
State of Washington	G	State Road	5,000
Cerro Gordo County, Iowa	G	Secondary Roads	20,000
		Total	$7,942,618
		Decrease	4,200

LIST NO. 45

Locality	Loan and Grant or Grant	Type	Amount
McEwen, Tenn.	L. & G	Waterworks	$39,000
Lawrence, Kan.	L. & G	Streets	51,000
Lawrence, Kan.	G	Waterworks	3,000
Downey, Idaho (Decrease)	L. & G	Water mains	8,000
Kingman, Kan.	G	Hospital	600
Shallotte, N. C.	G	Garage	2,000
St. Louis Co., Minn	L. & G	School	122,000
West Liberty, Iowa	L. & G	Sewage Disposal	18,600
Craighead County, Ark	L. & G	Court House	112,000
North Vernon, Ind	L. & G	Sewage Disposal	40,000
Herne, Tex.	L. & G	Streets	26,000
Stanley, N. C	L. & G	Sewer System	100,000
Dearborn, Mich.	L. & G	Sewage Disposal	120,000
Greenville, Mo.	L. & G	School	36,000
Dooly County, Ga	L. & G	School	65,000
Shelby, N. C	L. & G	School	34,000
Bartlesville, Okla.	L. & G	Sewage Disposal	138,000
San Antonio, Tex	L. & G	Sewer System	159,000
Dallas, Tex.	G	Storm Sewers	98,000
Duluth, Minn.	L. & G	Streets	70,000
Carthage, Mo.	L. & G	Waterworks	107,000
Galena, Kan.	L. & G	School	28,000
Phoenix, Ariz.	L	Paving	147,000
Boulder County, Col	L. & G	School	468,000
Wabasha, Minn.	L. & G	Sewer System	51,000
Helena, Okla.	L. & G	Town Hall	7,000
Madison, N. C	L. & G	Waterworks	12,000
St. Louis County, Minn	L. & G	Schools	56,000
Windsor, Col.	L. & G	Waterworks	11,000
Pottawatomie County, Okla.	L. & G	Court House	250,000
Fox Point, Wis	G	Sewers	9,000
State of Massachusetts, Fitchburg	L. & G	College Building	99,000
Sequin, Tex.	L. & G	Court House	200,000
Urbandale, Mo.	G	Water	2,000
Grantville, Kan.	G	Channel Work	7,000
Chesapeake Shore Reconstruction Assn., Norfolk, Va.	L	Reconstruction	250,000
		Total	$2,938,200
		Decrease	8,000
		Grand Total	**$10,880,818**

Rail Coordinator Makes First Report on Transportation

JOSEPH B. EASTMAN, appointed last year to the position of railroad coordinator under the Emergency Railroad Transportation Act of 1933, submitted his first report to Congress on Jan. 20. The report makes few specific recommendations. The chief reason for submitting it at this time, according to reports in Washington, is to advise Congress that no major railroad legislation is to be introduced at this session.

Government ownership

Government ownership and operation of the railroads is favored by Mr. Eastman but he does not recommend it as an immediate undertaking, chiefly because of the cost involved. When it is put into effect he would have operations directed by a board of from five to seven trustees aided by an advisory council of 24 from outside the railroad field. The Interstate Commerce Commission would continue to regulate rates, accounting, new construction and acquisition of other transportation agencies.

Specific recommendations include removal of the present restriction on reduction of employees, granting of greater scope to the railroad managements in applying their own initiative to working out their problems, relief of the railroads from the anti-trust laws, setting up a temporary coordinator with powers similar to those of the present coordinator, continued federal support of the railroad financial structure, speeding up of reorganization of roads needing reorganizations, and provision for compulsory consolidations of a trial nature. For this latter purpose Mr. Eastman proposes that federal corporations be organized into which railroads can be consolidated by exchange of securities. Most of his recommendations, Mr. Eastman states, can be made effective without further legislation.

Steamer Held Responsible for Damage to Movable Bridge

The Admiralty Court in Canada has held that the steam *Philip T. Dodge* is responsible for damage to a movable bridge across the York River entrance in the Gaspe Basin, Quebec, resulting from a collision with the bridge on July 1, 1932. The bridge was in the course of construction by the Dominion Bridge Co. at the time of the accident. The steamer, making its first passage through the opening, swung against the bridge, striking the north bascule and seriously damaging both the bascule and its operating gear. The ship's master maintained that the construction work was a menace to navigation, but the court ruled that as the construction had been authorized by the Minister of Public Works it could not be so considered. It held further that the master was at fault for not having stopped the ship to ascertain the conditions to be met.

The decision is of special interest in Canada because of a similar accident to the second Narrows Bridge at Vancouver a year or more ago.

Consulting Engineers' Institute Elects G. W. Burpee President

George W. Burpee was elected president of the American Institute of Consulting Engineers at a meeting of the council of the Institute on Jan. 16, succeeding Charles Page Perin, president in 1932 and 1933. Fred Lavis was elected vice-president and Philip W. Henry was re-elected secretary and treasurer.

Mr. Burpee is a member of the firm of Coverdale and Colpitts, New York, and in addition to the Institute is a member of the American Society of Civil Engineers, American Railway Engineering Association and the Engineering Institute of Canada. He is a graduate of Bowdoin and of the Massachusetts Institute of Technology.

At the annual meeting of the Institute held the previous night, Fred G. Cunningham and Gavin Hadden, of New York, and Maurice R. Scharff, of Pittsburgh, were elected members of the council.

The speaker at the annual meeting was Jerome C. Hunsaker, recently appointed head of the department of mechanical engineering and of the Guggenheim Aeronautical Laboratory of the Massachusetts Institute of Technology. Dr. Hunsaker's talk was devoted chiefly to a comparison of the costs of transportation by land, water and air. Making due allowance for the value put upon speed, he found transportation by air in an already established place, with promise of still more successful competition as improvements are made.

In his report as secretary of the Institute Mr. Henry listed a present membership of 104. Of these 37, with 25 guests, were present.

New Head of Inspection Division

Howard A. Gray, formerly executive vice-president of the Yates-American Machine Co. of Beloit, Wis., has been appointed director of the division of inspection of the Public Works Administration to succeed William M. Steele, who has resigned.

The division of inspection checks up on work that is being carried out with PWA loans and grants, inspectors being assigned to the job from start to finish.

Hudson River Pollution Steadily Increasing, Investigator Tells Sewage Association

DISCUSSIONS at the sixth annual meeting of the New York State Sewage Works Association, meeting in New York City on Jan. 16, were featured by a preliminary report presented by Prof. Earle B. Phelps, of Columbia University, on his investigation of pollution of the Hudson River. Professor Phelps reviewed the work that has been done during the past 25 years in studying the pollution of the waters of New York harbor, starting with the work of Black and Phelps in 1910. The early work was characterized by an attempt to arrive at a quantitative concept of pollution, nowadays provided by biochemical oxygen demand. As an index of the degree of pollution the dissolved oxygen content of the water has been used in these studies.

It is significant to note that the dissolved oxygen deficiency has been displaying a general increase during all this period of study. The New York harbor problem is tremendously complicated by the variations in the flow of the Hudson River and the complexities of tidal movements within the several areas of the harbor itself. Evidence is strong, however, that the Hudson River flow is a major factor in determining the dissolved oxygen content of the harbor waters. Early estimates as to the increase to be expected in future years in dissolved oxygen deficiency, although considered over-estimates at the time, have proved to be conservative rather than liberal. There is some evidence, however, that there is superimposed on the general trend line a cyclical variation with a period of about 22 years.

Professor Phelps' paper was discussed by George A. Soper, George W. Fuller and Richard A. Gould. Dr. Soper cautioned against using dissolved oxygen as the sole criterion in determining the desirability of pollution abatement. Many other considerations, he said, are involved, the most important of which is the concentration of polluting material in the neighborhood of sewer outlets. These local conditions are of extreme importance and are not properly reflected in the dissolved oxygen examination.

A comprehensive paper was presented by A. J. Fischer, of New York City, on "Digester Overflow Liquor." Dr. Fischer announced that the volume and characteristics of such overflow liquor vary quite widely from plant to plant. A number of factors were cited which increase the solids content of overflow liquor. These include rapid digestion, agitation of the tank content, and high temperature. Five methods of disposing of the overflow were listed. They comprise elimination of the overflow by the drawing of thin sludge, chemical treatment of the liquor, storage to precipitate the solid material, disposal on sand beds and its return to the raw sewage entering the plant. The last mentioned method of disposal was recommended.

The results of tests on the circulation of sludge in digestion tanks at Baltimore, Md., were described by C. E. Keefer. Two identical digestion tanks were operated side by side, in one of which the sludge was circulated by means of a Prüss pump. In the other tank no circulation was employed. Results did not indicate any material advantage to be derived from the circulation.

Operating results of a six-months test period of a plant employing the Guggenheim process at Chicago were presented by G. H. Gleason, New York City. Andrew M. Holmstrom described the selection and utility of porous diffuser plates.

Edmund B. Besselievre, of New York City, was elected president for the ensuing year, and Morris M. Cohn of Schenectady was elected vice-president. A. S. Bedell, State Department of Health, Albany, was reappointed secretary-treasurer.

New Set of Bids To Be Called on Kansas City Auditorium

New bids have been called on the proposed municipal auditorium at Kansas City, to be opened on Feb. 7, following instructions from the Public Works Administration in Washington. The bids will be on the same plans that were put up for bid in November and again in December, following some modifications in specifications.

Engineers To Determine Cause of Low Water at Montreal

The Canadian government has appointed a committee of engineers to inquire into the cause of the low water level that has existed in the St. Lawrence river channel from Montreal downstream in recent years and to report upon action necessary in order to correct the situation. The low level during the late fall this year seriously hampered navigation in Montreal harbor.

The committee, composed entirely of engineers in the federal government service, is as follows: N. B. McLean, chief engineer of the St. Lawrence Ship Channel division of the Dept. of Marine, Ottawa, (Chairman); A. Lafleche, assistant chief engineer of the division; F. Anderson, director, hydrographic survey; K. M. Cameron, chief engineer, Dept. of Public Works, Ottawa; J. L. Dansereau, district engineer, Montreal; J. T. Johnston, director, Dominion Water Power and Hydrometric Bureau, Ottawa; D. W. McLachlan, chief engineer, St. Lawrence Waterways and Hudson Bay Terminals, Dept. of Railways and Canals, Ottawa.

Further Delays in Prospect for New York Post Office Project

Further delays in the award of a contract for the post office annex at New York, to be built over the Pennsylvania Railroad tracks directly behind the present main post office, now appear certain in view of the charge made on the Senate floor recently by Senator Tydings that "certain influences are conniving towards awarding of an illegal contract."

When the third set of bids on the annex was opened late in December new complications developed in addition to those developed earlier in connection with the project. The George F. Driscoll Company, Brooklyn, former low bidder, submitted the low bid for the complete building, $4,293,790, and the second-low bid for the building complete except for mechanical equipment on the fourth and fifth floors and some minor interior work, $4,043,790. James Stewart & Company, New York, submitted a low bid of $3,997,000 for the building less the mechanical equipment of the fourth and fifth floors and the second-low bid on the completed building $4,207,000. Due to some omission from the specifications, other alternate bids were permitted that further add to the uncertainty as to who will receive the contract for the work.

As noted previously (*EN-R*, Nov. 2, p. 540; Nov. 16, p. 607, and Nov. 30, p. 668), the earlier bids were thrown out on account of confusion over signing the President's Re-employment Agreement.

New York Road Men Organize to Fight Diversion of Gas Tax

Highway users from the state of New York, at a crowded meeting held in the State Education Building in Albany on Jan. 19 laid the foundation for the organization of the New York State Highway Users Conference to cooperate with the National Highway Users Conference. The meeting was presided over by Warner Bates, secretary of the New York State Automobile Association. Speakers included J. W. Bryan, Washington, representing the Highway Users Conference, J. S. Crossley, and Willard T. Chevalier. A film talk on taxation by Edward C. Hill was shown.

SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, Toronto, Ontario, Canada, Feb. 20-22, 1934.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill., March 13-14, 1934.

AMERICAN ROAD BUILDERS ASSOCITION, annual convention, Chicago, Jan. 22-26, 1934.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN TOLL BRIDGE ASSOCIAtion, annual convention, Cincinnati, Ohio, Jan. 26-27, 1934.

AMERICAN WOOD PRESERVERS ASSOCIATION, Houston, Texas, Jan. 23-25, 1934.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

ASSOCIATED GENERAL CONTRACTORS, annual convention, Washington, D. C., Jan. 29-31, 1934.

CONSTRUCTION LEAGUE OF THE UNITED STATES, annual meeting, Willard Hotel, Washington, D. C., Feb. 1-2.

ENGINEERING INSTITUTE OF CANADA, 48th annual general meeting, Montreal, Que., Feb. 8-9, 1934.

SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

KENTUCKY - TENNESSEE SECTION, American Water Works Association will meet March 1-3, at Knoxville, Tenn. F. C. Dugan, Louisville, Ky., is secretary-treasurer.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY will meet Feb. 22 and 23 in Minneapolis. Codes, registration, PWA, CWA, CCC, flood control and water conservation and the Upper Mississippi development are subjects scheduled. L. P. Zimmerman, is secretary-treasurer.

MINNESOTA FEDERATION OF ARCHITECTURAL AND ENGINEERING SOCIETIES will meet Feb. 24 in Minneapolis immediately following the convention of the Minnesota Surveyors and Engineers Society. Housing, the utility problem, economic future of the Northwest are scheduled as topics. Katherine A. Feucht is secretary.

ILLINOIS SOCIETY OF ENGINEERS meets Jan. 31-Feb. 2 at Springfield. Seven sections of the society will have programs. The drainage section will discuss soil erosion, flood control, structures and appraisals. The sewerage section has scheduled sludge-gas engine operation, sludge economics, research and construction. Topics in the water supply section program relate to wells, measurement in elbows, flora, water resource investigations. In the structural section the papers scheduled will cover fatigue of metals, concrete mixtures and control and bridge construction. The road and pavement section will discuss gas tax allocations, CWA for road betterment and black top. The surveying section will hear how to relocate corners and lay out subdivisions. In the only general session public affairs will be discussed in ten talks on CCC, CWA, PWA, codes, ethics, fees, registration and opportunities. Prof. H. E. Babbitt, Urbana, is secretary.

Brief News

BIDS HAVE BEEN CALLED by the U. S Bureau of Reclamation on the emergency gates and needle valves for the canyon wall outlet works at Boulder Dam, bids to be in by Feb. 5.

A NEW STRUCTURE costing $225,000 is planned by the University of Tennessee to replace Morrill Hall, burned on Jan. 18. The PWA has authorized a loan of $493,000 to the university for new construction.

CONSTRUCTION OF TOLL BRIDGES by subdivisions of the state of Missouri out of the proceeds of bond issues and the retirement of bonds from revenues is authorized in emergency measures recently signed by Governor Park.

CONSTRUCTION OF A NEW BRIDGE by the Kentucky Highway Commission across the Ohio River at Owensboro, Ky., has been approved by the War Department. The bridge will have two navigation openings, each opening having a horizontal clearance of 750 ft. and a minimum vertical clearance of 46 ft.

ERECTION OF STEEL WORK on the Second Narrows Bridge at Vancouver, B. C., has been commenced by the Dominion Bridge Co. Concrete work for the major repairs to this bridge across Vancouver harbor has been completed by the Foundation Company of Canada, holders of the general contract. The bridge was badly damaged some months ago when struck by a vessel.

AERIAL MAPPING OF THE RESERVOIR AREA above the proposed dam No. 3 on the Tennessee River is under way, the work being carried out by Edgar Tobin Aerial Surveys of San Antonio, Texas. The survey will cover a tract of 678 square miles. A survey of the Norris Dam reservoir area, 837 square miles has been completed.

A SUIT TO PREVENT the construction of a municipal light and power plant at Concordia, Mo., has been filed in the U. S. District Court for the Western District of Missouri. Recently the citizens voted a $70,000 bond issue and subsequently the Public Works Administration allotted $47,000 to the city. The suit is being brought by the Missouri Public Service Co., which has a plant at Concordia.

CONSTRUCTION OF THE RAILROAD AVE. SEAWALL and paving project in Seattle, Wash., has been undertaken on a day-labor basis under the direction of the city engineer, M. O. Sylliaasen, under an order issued recently by the board of public works. For months past the city has been endeavoring to obtain satisfactory bids for the construction of the project by contract. The cost is estimated at $1,396,000.

PROGRESS IN THE DEVELOPMENT of regional recreational areas was reported at a recent meeting in Washington of district officers of state park emergency conservation work and officials of the Office of National Parks, Buildings and Reservations. Operations are underway in 182 parks in 32 states. There are now 238 CCC camps, with an enrolled personnel of 47,600, located on such projects. Cooperation of the federal government dates back 8 months when President Roosevelt authorized employment of CCC men for this purpose.

Personal

Capt. Richard Morgan Watt, C. of E., U. S. Navy, now on duty at the shipyards at Kearny, N. J., has been promoted to the rank of rear admiral.

R. K. Van Camp, formerly division engineer, state road department, Lakeland, Fla., has been appointed engineer-examiner for the Public Works Administration with headquarters at Tallahassee, Fla.

C. D. O'Neil, city engineer, Ashland, Ky., has been named director of public works in addition to his position as city engineer in a consolidation authorized recently by the commissioners of the city.

Robert T. Colburn, formerly with the Stone & Webster Engineering Corp., has been appointed a designing engineer for the Tennessee Valley Authority at Knoxville on the Norris dam project.

Harold English, president, English & Lauer, Los Angeles, has been appointed director, Civil Works Administration, for Los Angeles county to succeed **Jules Hanique**, who becomes project engineer for the Administration in that county.

Joseph C. Gilbert, formerly with the engineering department of United Engineers & Constructors, Inc., has been appointed a field engineer with the Tennessee Valley Authority on the construction of the Joe Wheeler dam in Alabama.

Francis Beal Marsh, New Rochelle, N. Y., has been appointed a special associate civil enginer to assist in work being done by a special committee investigating additional sources of water supply for Baltimore.

Julius R. Hall, formerly general superintendent of construction at the Century of Progress exposition at Chicago has returned to John Griffiths & Son Co., Chicago, as superintendent of Lock No. 26 at Alton, Ill., under construction by the Corps of Engineers.

James S. Lewis, Jr., has resigned as construction engineer for the Virginia Public Service Co. and has been appointed assistant designing engineer in the Knoxville office of the Tennessee Valley Authority. Mr. Lewis formerly was resident engineer for the Electric Management & Engineering Co. on the construction of the Bremo steam plant for the Virginia Public Service Co.

Obituary

Harry R. Bricker, for 13 years superintendent of construction for the Public Improvement Commission, Baltimore, died there on Jan. 20. Previous to his connection with the Public Improvement Commission he was chief labor agent for the Baltimore & Ohio Railroad.

C. Eric Nordell, engineer of Ocean Township, New Jersey, died at his home in Long Branch, N. J., Jan. 15. Mr. Nordell was a graduate of Rennselaer Polytechnic Institute and for 15 years was employed in the bridge department of the Central Railroad of New Jersey.

James F. McGraw, superintendent of construction, Buffalo, Niagara & Eastern Power Co., died at his home in Buffalo on Jan. 15, age 63 years. Mr. McGraw began work with the Niagara Falls Power Co. in 1892 as an inspector on construction, becoming superintendent of construction for the Niagara, Lockport & Ontario Power Co. in 1922.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards aggregate $22,581,000 for the past week, a slight drop from previous week's total of $23,942,000 and from the four weeks' average of $23,792,000. Again the drop is in highway awards. The road contract total for this week is $7,067,000, compared with $7,226,000 last week and a previous 4-weeks' average of $9,700,000.

Private work is up to $4,008,000 from $2,812,000 last week, while public work is down to $18,631,000 from $21,130,000 last week. It is, however, close to the previous 4-weeks' average of $19,887,000.

Bridges, with two large contracts, total $3,500,000, $300,000 over last week's high total. Industrial buildings are up to $2,089,000. Commercial buildings at $1,315,000 are holding fairly steadily at a three weeks' level. Public buildings are down to $2,413,000.

Large awards of the week include: a $1,290,000 road letting in Mississippi and a $1,285,000 road letting in Kansas; the Navy Yard causeway, Mare Island, Calif., $901,700; the substructure of State Highway Department bridge over Fore River, Mass.: $912,112; locks at Dubuque, Ia., $1,437,813 and at Burlington, Ia., $1,344,429.

While new capital is low this week, the drop is all in PWA allotments. A favorable factor in this market is indicated by the fact that municipal bond sales, totalling $4,452,000 the first week of this year, $1,313,000 the second, $2,127,000 the third, rose to $6,427,000 this week.

CONTRACTS
(Thousands of Dollars)

	Weekly Jan. 1933	Average Prev.4 Weeks	Week Jan.25, 1934
Federal Government	$3,636	$6,635	$7,863
State and municipal	15,810	13,503	10,768
Total public.....	$19,446	$19,887	$18,631
Total private....	4,402	3,905	4,008
Week's total.....	$23,848	$23,792	$22,581

Cumulative to date:
1933......$95,392 1934......$101,581

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

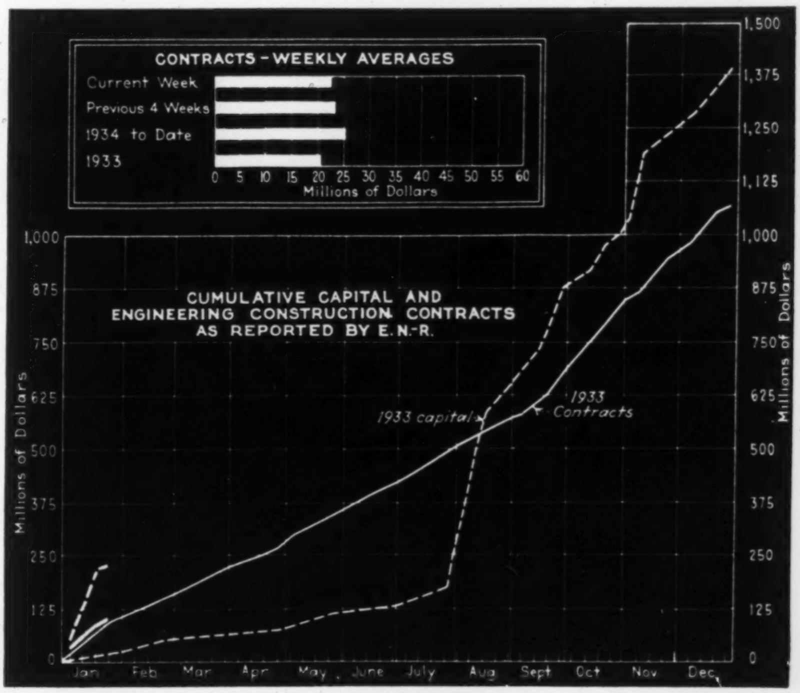
1934	Week Jan. 25	Cumulative
State and municipal....	$6,427	$14,319
PWA allotments, S&M..	9,375	170,947
Corporate issues........	....	2,905
PWA allotments, private	397	36,024
Total, Non-Federal...	$16,199	$224,195
PWA allotments Federal Constr.	358	44,934
Total new capital....	$16,557	$279,129

Cumulative total to date:
1933......$24,700 1934......$224,195
Rescinded or reduced allotments (from 1933 PWA totals)....... $32,502

INDEX NUMBERS

E.N.-R.-Cost		E.N.-R.-Volume	
January, 1934	**191.26**	**December, 1933**	**116**
December, 1933..	192.14	November, 1933..	133
January, 1932....	158.44	December, 1932...	113
1933 (Average)...	170.28	1933 (Average)...	102
1932 (Average)...	156.97	1932 (Average)...	127
1931 (Average)...	181.35	1931 (Average)...	220

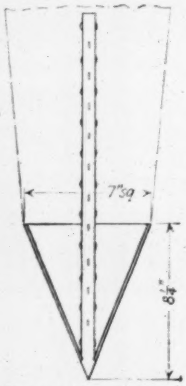
1913 (Average)............... 100



Construction Equipment and Materials

Steel Shoe for Concrete Piles

The American Pulley Co., Philadelphia, Pa., has recently developed and placed on the market the "American" No. 3 pile shoe for precast concrete piles. The shoe consists, briefly, of a hollow four-sided pyramid of heavy steel plate with a deformed steel bar, pointed at the lower end, forming the point of the shoe, welded securely to it, and extending up the vertical center line of the shoe for a length of about 2 ft. This shoe is placed in the forms before pouring the concrete and the deformed bar forms an anchorage to fasten the pile shoe to the concrete pile.



"American" shoe for precast concrete piles

The standard size has a 7-in. square base, but the same type of shoe can be manufactured specially to the dimensions required.

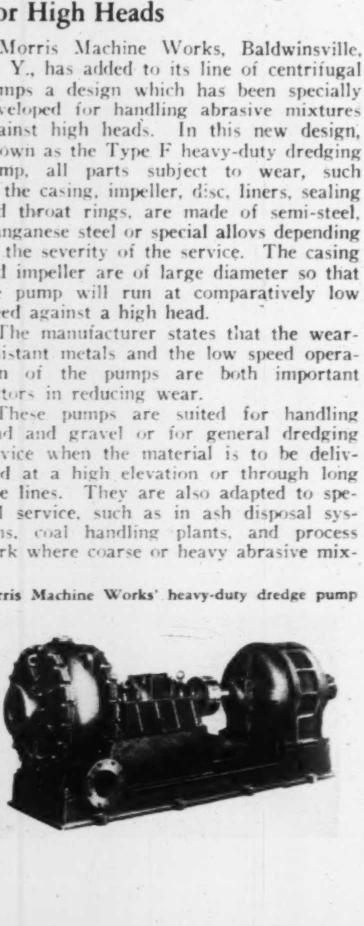
Heavy-Duty Dredge Pump For High Heads

Morris Machine Works, Baldwinsville, N. Y., has added to its line of centrifugal pumps a design which has been specially developed for handling abrasive mixtures against high heads. In this new design, known as the Type F heavy-duty dredging pump, all parts subject to wear, such as the casing, impeller, disc, liners, sealing and throat rings, are made of semi-steel, manganese steel or special alloys depending on the severity of the service. The casing and impeller are of large diameter so that the pump will run at comparatively low speed against a high head.

The manufacturer states that the wear-resistant metals and the low speed operation of the pumps are both important factors in reducing wear.

These pumps are suited for handling sand and gravel or for general dredging service when the material is to be delivered at a high elevation or through long pipe lines. They are also adapted to special service, such as in ash disposal systems, coal handling plants, and process work where coarse or heavy abrasive mixtures are to be handled. The pumps are built in a complete range of sizes from 4-in. to 15-in. discharge, for total heads up to 150 ft., and for operation by electric motor or belt.

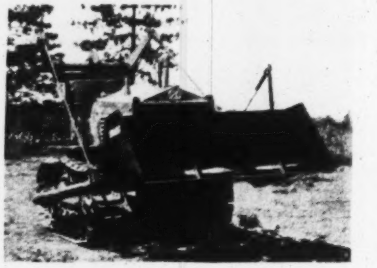
Morris Machine Works' heavy-duty dredge pump



Front-End Loader for Use With Cleveland Tractor

The Euclid-Armington Road Machinery Co., Cleveland, Ohio, has introduced the Euclid front end loader for use with the Cletrac 20, 25, or 35. The loader utilizes the operating mechanism on the rear of the tractor as a counterbalance.

The unit is hydraulically operated and is controlled by a single lever. The bucket automatically stops at its highest and lowest positions and may be dumped at any desired height.



Euclid front-end loader

The tractor may be used for other work with the loader attached, or by the removal of two bolts on the lifter arms and the collars on the cross shaft the tractor can be quickly backed out of the bucket and push arms.

Business Notes

TRAYLOR ENGINEERING & MFG. CO., Allentown, Pa., announces the opening of a new district office at Little Rock, Ark., to serve western Tennessee, Arkansas, Louisiana, Texas, Oklahoma and Kansas. The new office is in charge of B. W. Traylor.

REVERE COPPER & BRASS, INC., New York, N. Y., announces the appointment of Robert G. Scott as a vice-president of the company in charge of the Taunton-New Bedford Division, with headquarters at Taunton, Mass.

CAPITOL STEEL CORP. OF N. Y., Brooklyn, N. Y., has acquired the old Kalman steel concrete bar warehouse in Jersey City. Welding equipment is to be installed for fabricating welded products. The company's New York office and warehouse will continue to function as heretofore.

DITWILER MFG. CO., Galion, Ohio, announces that it has recently acquired the Schultze split shaft power takeoff for motor trucks, which has been manufactured for several years by the Schültze Mfg. Co., of Bloomington, Ill. The device is to be known in the future as the Ditwiler split shaft power takeoff. Schultze patent.

LANSDALE STRUCTURAL STEEL & MACHINE CO., Lansdale, Pa., is a new corporation which has purchased the steel fabricating plant formerly operated by Kirby Iron Works. Joseph Roberts, formerly designing engineer for Proctor & Schwartz, Philadelphia, will be president and chief engineer of the company. Norman P. Farrar, formerly sales manager of Harnischfeger Corp., Milwaukee, will be vice-president and treasurer. The business of the new company will be the manufacture of steel framed structures and machinery and steel erection.

New Equipment in Brief

Diesel locomotive. The Fate-Root-Heath Co., Plymouth, Ohio, announces a new 12-ton diesel locomotive. The new locomotive is powered by a Caterpillar diesel engine, developing 102 hp. at 820 r.p.m. One of the new Plymouth features is the one-piece frame built of steel plates. All joints of the frame are solidly welded and are thoroughly braced. There are four speeds forward and four speeds reverse.

Welding Electrode. An electrode for welding cast iron by the shielded arc process has been announced by the Lincoln Electric Co., Cleveland, Ohio. The electrode is known as "Ferroweld," and it is claimed that it produces a weld of greater strength and ductility than the cast iron itself. "Ferroweld" has a steel core surrounded by a heavy flux coating which protects the arc from injurious gases. The welding is done intermittently, not over a 3-in. bead being laid down at one time. As each bead is welded it is peened lightly, cleaned and allowed to cool before the next bead is deposited. The electrode is used with about 80 amp. of current.

New Publications

Gunite. The Cement Gun Co., Allentown, Pa., in their Bulletin 200 entitled "The Cement Gun and Its Sand-Cement Product Gunite." This bulletin, consisting of 49 pages, describes in detail the cement gun equipment in numerous gunite applications.

Steel Products. The Heltzel Steel Form & Iron Company, Warren, Ohio has issued a new Plate Shop Catalog which shows a large variety of steel plate products fabricated by Heltzel. The publication is replete with photographic illustrations.

Compressors. Worthington Pump & Machinery Corp., Harrison, N. J., has just issued an 8-page pamphlet describing single horizontal, single stage compressors, steam or motor driven. The characteristics of the component parts of the machine are illustrated and described.

Aluminum. Revised editions of the booklets "The Welding of Aluminum" and "The Riveting of Aluminum" have been published by the Aluminum Company of America, Pittsburgh, Pa. These booklets give the latest information on joining aluminum and incude many data not contained in the earlier editions.

Compressors. A 28-page catalog describing Worthington horizontal duplex motor driven compressors has been issued by the Worthington Pump & Machinery Corp., Harrison, N. J. The booklet is designated L-612-C1A. The booklet contains detailed descriptions of the salient features of these compressors, including the Worthington feather valve.

Iron pipe. The Republic Steel Corp., Youngstown, Ohio, has just published a 64-page booklet entitled "Toncan Iron Pipe for Permanence." Part 1 is given over to technical data and tests of this material under various conditions. Part 2 includes a collection of installation and service records in a wide variety of applications. The catalog is referred to as Form AB-220-C.

Tunnel Liner Plates. "Commercial Tunnel Liners" is the title of a 38-page booklet published by the Commercial Shearing & Stamping Co., Youngstown, Ohio. The book describes in considerable detail the use of steel liner plates in tunnel construction. A number of methods of tunnel construction using the liner plates are described and there are a great number of photographic and diagrammatic illustrations. The use of liner plate for caissons and shafts is also described.

Lathes. "Underneath Belt Motor Driven Lathes" is the title of Bulletin No. 101-A, just published by the South Bend Lathe Works, South Bend, Indiana, illustrating and describing both underneath-belt-driven lathes and countershaft-drive lathes. The same company also announce the appearance at an early date of a 32-page booklet, "Motor Mechanic's Handbook No. 33," showing the latest practical methods for handling some of the major maintenance jobs on equipment such as power shovels, tractors, trucks, and pumps.